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The New Manhattan Station of the Brooklyn Bridge

The work of rebuilding the Manhattan station of the Brooklyn Bridge has been put under way by the Department of Bridges, New York City. We are indebted to Arthur J. O'Keefe, Commissioner of Bridges, for a photograph of the original water-color drawing from which the accompanying view has been reproduced. The view shows the front of the station, as it will appear from beyond and above Broadway, looking across City Hall Park and over the City Hall.

THE NEW MANHATTAN STATION OF THE BROOKLYN BRIDGE, THE NEW MUNICIPAL BUILDING AND THE CITY HALL PARK RESTORED, NEW YORK CITY

The present cheap type of steel construction is to give way to a more worthy architectural masonry façade and fitting roof, and the hideous bridge over Park Row and Center St. will be replaced by a ramp or an inclined walk terminating in the easterly part of City Hall Park. By means of a properly subordinated structure extending to the northward from the front portion of the new station an overhead connection to the Third Avenue Elevated Ry. will be effected; and by a further extension, carried westwardly above and across Park Row, a connection will be made with the new Municipal Building, which dominates the whole scene shown by our illustration.

The basement of this Municipal Building, it may be explained, will serve as a terminal of the loop subway now being built to connect the Brooklyn with the Manhattan and Williamsburgh Bridges. There will thus center here: (1) The Manhattan terminal of the Brooklyn Bridge, at which both the surface cars and elevated railway lines of Brooklyn discharge their passengers; (2) the southerly end of the Third Avenue Elevated; (3) the subway loop, just mentioned; (4) the Brooklyn Bridge Station of the original New York (Manhattan) subway.

Why the Municipal Building was not so placed as to house in a single magnificent structure all four of these stations is a question that will naturally occur to many. The question is too large and complex to answer here, further than to point out that with the proposed overhead and (we suppose) underground connections, as much unification of traffic housing will perhaps be provided as is consistent with a proper separation of the traffic streams; and that it has not yet been possible to harmonize the conflicting ideas of rival city departments, on the one hand, and the interests of private corporations, on the other. Consequently, in this and other transit matters the public, to serve which both municipal departments and private corporations alike are created, continues to suffer in convenience, purse and unsatisfied civic and esthetic ideals.

Passing to other considerations, it may be noted that the view shows the City Hall Park freed from the incumbrance of the old Post Office, as well as from the somewhat less architecturally objectionable Tweed Court House of unsavory memory, and the nondescript brown-stone building between it and the Brooklyn Bridge. The view also shows the proposed new court house, which it has just been decided to locate north of the new Municipal Building. We have commented upon these proposed changes in our editorial pages.

Ore Dock at Cleveland, O.

The unloading of ore steamers at the lower ports on the Great Lakes, with the storage and subsequent rail shipment of the ore, calls for extensive construction works and machinery equipment to ensure speed and economy in the handling of the material. Rapid unloading by machinery is especially necessary, on account of the great size of the ore boats and the desirability of reducing their stay in port to a minimun, so that they make as many trips as possible during the season for navigation. This article describes one of the latest and most complete plants of this kind, including an ore dock, ore stock yard, railway yard, machinery for unloading ore from steamers, and machinery for delivering this ore to the stock piles and from the stock piles to railway cars for shipment.

An important extension of the facilities of Cleveland, Ohio, as an ore-receiving port is being made by the Pennsylvania Co. in improving the water-front terminal of its Cleveland & Pittsburg Division. Information regarding this work has been furnished us through Mr. Trimble, Chief Engineer of Maintenance of Way, Pennsylvania Lines (northwest system), and this has been supplemented by information obtained from some of the contractors.

The present ore-handling facilities of the Pennsylvania Lines at Cleveland are located on a branch of the Cuyahoga River, upon property known as Whiskey Island. This property is south of the Lake Shore & Michigan Southern Ry., which lies between the lake and the Pennsylvania Co.'s property. The channel to the present ore docks on this property is very crooked, and is spanned by three drawbridges, one of which is the single-track swing bridge which carries all the main-line traffic of the L. S. & M. S. Ry. and the dock traffic of the Pennsylvania Co. The movement of a boat to the docks is therefore tedious and difficult, requiring the services of two tugs, and it is only by cutting off corners that the large ore boats have been able to reach the docks. The track system also necessitates a great amount of switching. The ore-handling machinery consists of Hoover & Mason unloaders and Brown conveyor bridges.

Development of New Facilities

For several reasons (including the difficulties noted above) the Pennsylvania Co. decided to develop its property on the lake front, north of the L. S. & M. S. Ry. This property is located within what is known as the West Breakwater, and its water front is on the established harbor line. The development included the following work: (1) reclaiming land by filling, and protecting it by rip-rap walls; (2) building an ore dock and foundations for the tracks carrying ore unloaders and conveyor bridges; (3) erecting the ore-handling machinery, providing tracks for electric locomotives to handle the railway cars at the machines, and building a power house; (4) building a yard system for the railway cars; (5) building a double-track subway under the seven tracks of the L. S. & M. S. Ry. The general layout of the new facilities on this property is shown in Fig. 1.

An area of approximately 40 acres has been reclaimed by filling with slag and other refuse material obtained on the Cleveland & Pittsburg Division of the Pennsylvania Lines. In order to protect the government channel during the progress of this work, and also to facilitate the work, a temporary trestle was built, as shown on the plan. This was a wooden-pile trestle, filled with rip-rap. The trestle parallel to the shore line was located a considerable distance back from the established harbor line, so as not to interfere with the construction of the dock and machinery foundations in the space between the fill and the harbor line.

The work of unloading material for the fill was carried on from the shore outward and from the trestle shoreward. After the cars had been unloaded by hand labor the material was distributed and leveled by a track spreader, and the track was then shifted toward the edge of the bank thus made. Some experiments were made for handling the material with a locomotive crane equipped with a grab bucket, but this method did not prove so economical as the hand labor. The amount of filling material deposited was about 1,000,000 cu.yd., forming an area of made land 1850x850 ft.

Concrete Dock and Walls

The ore dock consists of a dock wall 1000 ft. long and a rear wall about 800 ft. long, the two walls being tied together by transverse walls. Where the dock wall extends beyond the other, its tie walls end in concrete anchor blocks. All these walls are of reinforced concrete and are supported on concrete piles, as shown in Figs. 2 to 4. The tracks carrying the front and rear legs of the unloader machines are laid upon the dock wall and rear wall, respectively.

The dock wall, 1000 ft. long, has a double row of reinforced-concrete piles

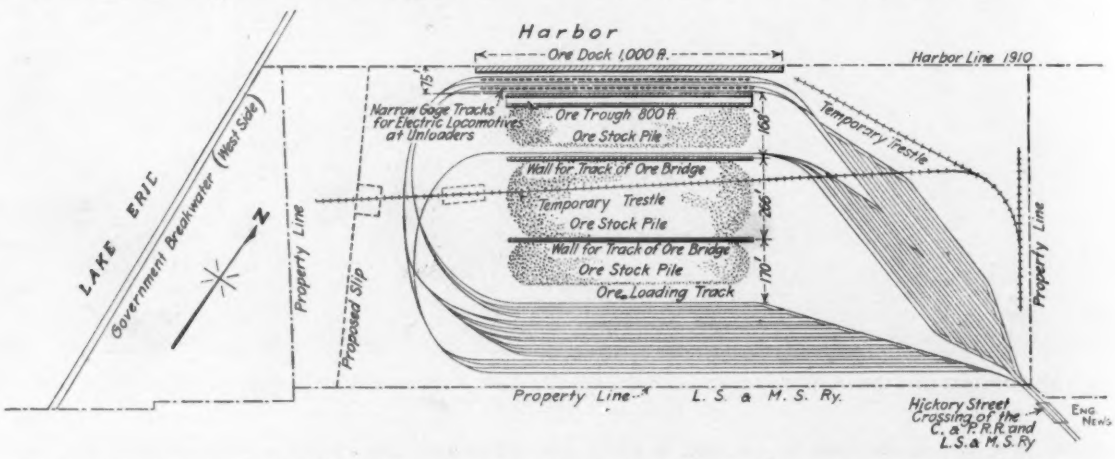


Fig. 1. General Plan of New Ore Dock and Stock Yard at Cleveland, Ohio; Pennsylvania Company

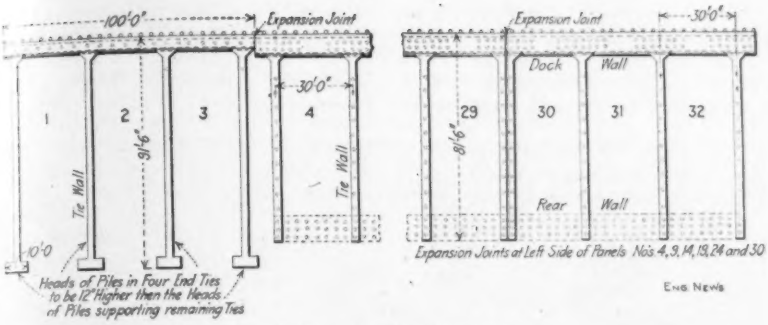


FIG. 2. PLAN OF CONCRETE DOCK

supporting a continuous concrete superstructure which is heavily reinforced with 85-lb. steel rails. The piles are 40 ft. long, and are spaced 3 ft. c. to c. Between these two rows of piles, concrete sheet piles, 10x12 in., are laid horizontally to form a face wall for the dock and to retain the filling, as shown in Fig. 3. The distance between the two parallel walls is about 75 ft. The tie walls are 30 ft. apart, on centers, and are supported on 30-ft. concrete piles. The rear wall is supported on three rows of similar piles spaced about 4 ft. apart. A bed of small rip-rap stone was filled around these rear piles, and the concrete for the wall was deposited upon this as a base.

It will be seen by the plan, Fig. 2, that expansion joints are provided at intervals along the dock wall, and that the west end of the wall is of slightly different construction from the rest. This latter feature is due to the fact that the rear foundation wall and the ore trough are about 100 ft. shorter than the dock wall. Fig. 3 shows the details of the main part of the ore dock, and Fig. 4 shows the west end. The dock wall and its reinforcement are shown in detail in Fig. 5, while Fig. 6 is a view of a part of the reinforcement in place. The steel rails in this work are spliced with angle bars fully bolted. The joints of rails in the lowest tier come over the groups of piles and are staggered. In the other tiers of rails no two joints are allowed to come together.

The space between the dock front (formed by the dock wall and the concrete sheet piling beneath it) and the rear wall was filled with rip-rap stone varying from shovel size to derrick size, a temporary wood trestle being built from which to handle the stone with a locomotive crane. After this stone filling had been brought up to the water level the whole mass was filled with sand pumped in by a hydraulic dredge. The face of the concrete dock is protected by a row of timber piles tied together with an oak waling piece, 12x12 in. The work under construction is shown in Fig. 7, with the dock wall at the right and the cross-tie walls connecting this with the rear wall at the left. Behind this rear wall is the floating concrete mixing plant, with its delivery spout leading to the forms. In front of this is a derrick scow placing the stone filling behind the wall, while on the track stands the locomotive crane used in placing the stone filling between the tie walls.

The space directly behind the rear foundation wall was filled with stone and made solid by pumping in sand, in the method above described. This was to form a foundation for the trough into which the ore is dumped by the unloaders and from which it is taken by the con-

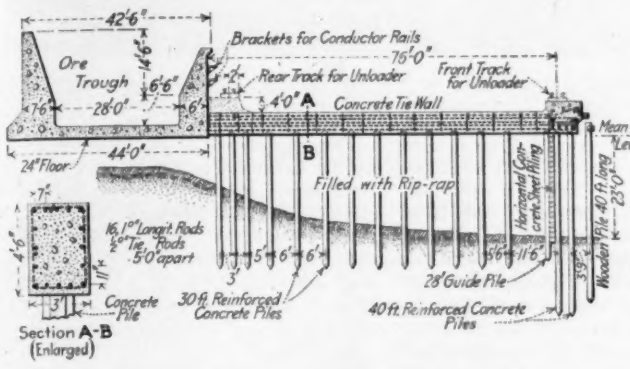


FIG. 3. CROSS-SECTION OF DOCK AND ORE TROUGH

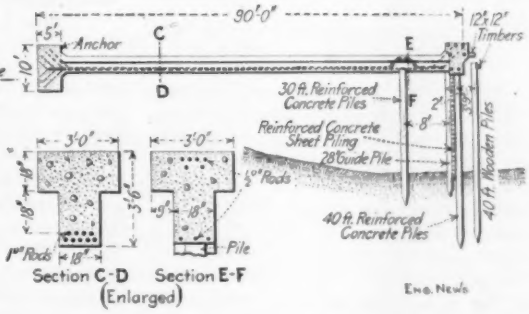


FIG. 4. CROSS-SECTION OF END OF DOCK (BEYOND THE ORE TROUGH)

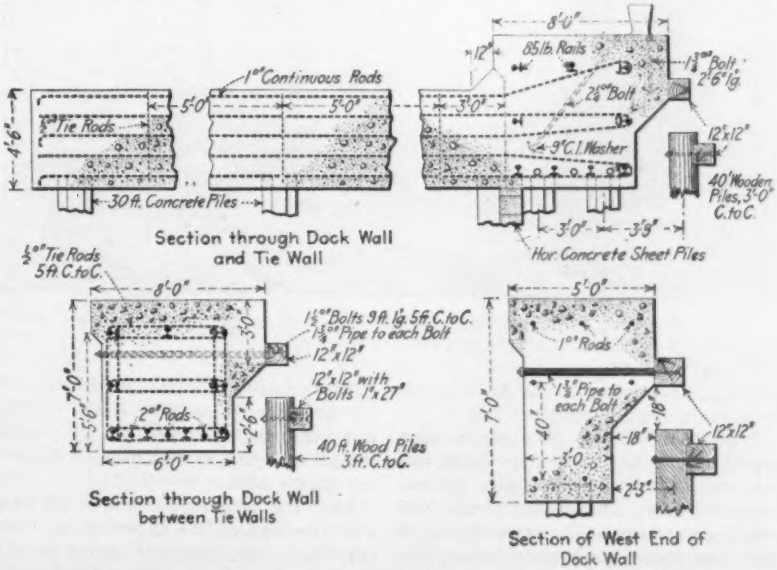

1" Continuous Rods
1" Tie Rods
5'-0"
30 ft. Concrete Piles
Section through Dock Wall and Tie Wall
85 lb. Rails
1 1/4" Bolt 2'6" lg.
2 1/8" Bolt
12"x12"
9" C.I. Washer
40' Wooden Piles, 3'-0" C. to C.
Hor. Concrete Sheet Piles
1/2" Tie Rods 5 ft. C. to C.
1 1/2" Bolts 9 ft. lg. 5 ft. C. to C.
1 1/2" Pipe to each Bolt
12"x12" with Bolts 1"x27"
2" Rods
40 ft. Wood Piles 3 ft. C. to C.
Section through Dock Wall between Tie Walls
1" Rods
1 1/2" Pipe to each Bolt
Section of West End of Dock Wall

FIG. 5. DOCK WALL AND TIE WALL, SHOWING STEEL REINNFORCEMENT

veyor bridges. This is shown in Figs. 1 and 3. The trough is of concrete, the bottom being protected by steel rails laid so that the top of the rail head is flush with the surface of the concrete. One wall of the trough has cast-iron brackets to support the conductor rails delivering electric current to the unloaders.

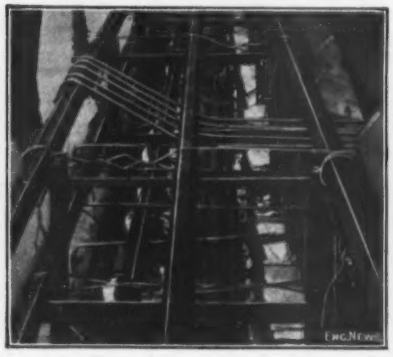


FIG. 6. STEEL REINFORCEMENT FOR DOCK WALL; CLEVELAND, OHIO

The ore trough and the walls for the conveyor bridge were built after the filling had been done (as described above). For this work, the concrete was made in a mixer plant mounted on a railway car and supplied with material from cars on the same track. Laborers with wheelbarrows delivered the materials from the supply car to the mixer car. This latter had a frame tower for an elevator bucket which received concrete from the mixer. One of these plants is shown in Fig. 10. For the footings, the concrete was deposited in place directly from the mixer by means of chutes. For the upper part of all the walls, the concrete was discharged into the elevator bucket which was then raised and dumped its contents into a hopper. From this hopper it was delivered to the forms by gravity through sheet-iron chutes, as shown in Fig. 13.

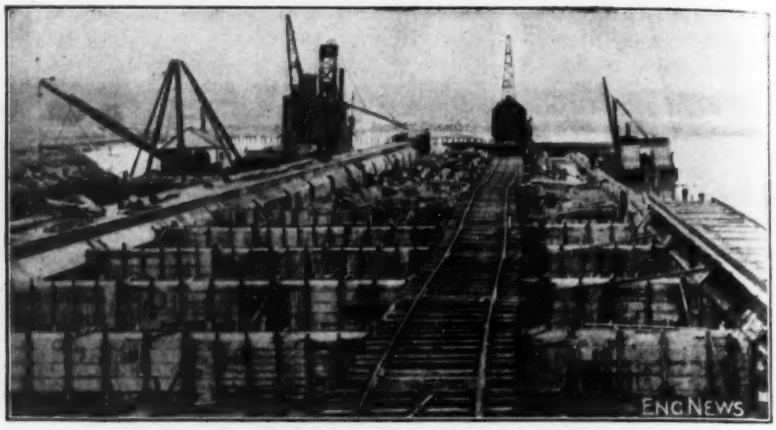


FIG. 7. CONSTRUCTION OF CONCRETE ORE DOCK AT CLEVELAND, OHIO; PENNSYLVANIA COMPANY

Beyond the dock wall and its rear wall for the support of the unloaders, there are two walls carrying the tracks for the conveyor bridges (Fig. 1). These are constructed as shown in Fig. 9. Each wall is supported by two rows of concrete piles, but the wall was placed upon these after the filling had been done. The wall which carries the main tower of the bridge has cast-iron brackets, 10 ft. apart, to support the conductor rails delivering electric current to the machinery. On the other wall these brackets are omitted. These walls have mortised expansion joints at intervals of 32 ft. Every fourth tie for the bridge track is secured to an anchor bolt in the wall, the bolts being 4½ ft. apart.

FIG. 8. FLOATING CONCRETE MIXER PLANT, DELIVERING CONCRETE TO FORM BY MEANS OF A CHUTE

About 3500 cu.yd. of concrete were placed in the dock wall, tie walls and rear wall. No particular difficulty was encountered in the construction of the concrete superstructure. The concrete for this work was made in a floating mixer plant which is shown in Fig. 8, the concrete being delivered to the forms by chutes. The concrete was a 1:3:6 mixture, and the quantities were 5900 cu.yd. for the two bridge walls and 9000 yd. for the ore trough, or a total of 18,400 cu.yd. including the ore dock.

The ore unloaders operate on two tracks located on the dock wall and the rear wall. The conveyor bridge travels on tracks on the other two walls already noted. The tracks are laid with 100-lb. rails, and every third tie is secured to a 1-in. anchor bolt set 17 in. in the concrete. Special tie-plates and clips are used, with screw-spike fastenings, as shown in Fig. 8.

The greater part of the work was done by the Great Lakes Dredge & Dock Co. Its contract covered the dock (with the manufacture and driving of all the concrete piles), the power-house foundations, and the substructure for the subway under the L. S. & M. S. Ry. The Dravo Contracting Co. constructed the ore trough and the walls for the conveyor bridge.

CONCRETE PILES

The reinforced-concrete piles are of a type designed by the engineers for the work and are shown in Fig. 11. They are of octagonal section, 13 in. thick across opposite faces. Each pile is reinforced by a steel skeleton of eight 1-in. rods connected by ties and brace rods and surrounded by a steel spiral of ⅜-in. rod. The tie rod was wrapped once around each longitudinal rod, and at each tie were two brace rods, the positions of these brace rods alternating at consecutive ties. The sheet piles, 10x12 in.

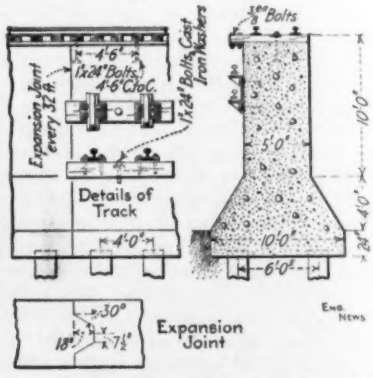


FIG. 9. SECTION OF WALLS FOR TRACKS OF ORE BRIDGE, AND DETAILS OF TRACKS

also shown in Fig. 10) have very similar reinforcement. The steel frames or skeletons were manufactured by a special machine in the contractor's shop. The piles were cast vertically in steel forms, a cast-iron shoe being placed in the form and becoming a part of the finished pile.

The concrete was a 1:2:4 mixture, using both gravel and broken stone; ¾-in. screened limestone was used in the latter case. A 1¼-yd. batch of cement mortar (1:1) was placed in the point. All material for the piles was delivered in cars and handled by a locomotive crane. As most of the piles were made in January, February and March, the materials were kept heated. Tunnels or conduits built of interlocking steel sheet piling were formed for this purpose under the piles of sand, gravel and broken stone, and steam pipes were placed in the elevated bin used in connection with the concrete mixer. The water also was heated in the same manner. After each form was filled, it was fitted with a steel cap and was then laid horizontally on the skids of the curing bed. There they were covered with tarpaulins, and live steam was allowed to circulate around them. After being on this curing bed for 12 to 24 hours (the time depending on the weather), the forms were removed; the piles were placed on the storage bed and allowed to season for at least 30 days. They were kept covered and heated for a considerable time after the removal of the forms.

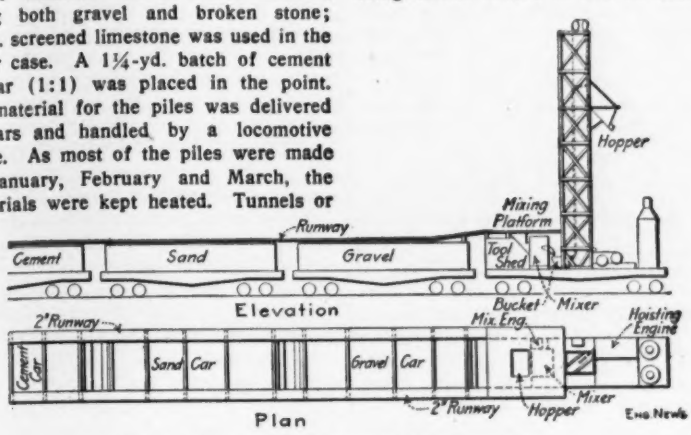


FIG. 10. TRAVELING CONCRETE MIXING PLANT

The contractors (the Great Lakes Dredge & Dock Co.) built an extensive plant for the manufacture of these piles, of which nearly 5000 were required. This plant included a cement warehouse, mixer, tower for the forms (for casting the piles vertically), electric-light station, and stock piles of sand and stone. Provision was made for heating these materials, as well as the water used and the concrete hopper, so as to allow the work to proceed during freezing weather. The mixer was in a building surmounted by bins for the aggregate. It discharged the concrete into a bucket traveling in the elevator tower and this bucket dumped the concrete into a hopper having a short chute to the top of the form. The forms were put in position and removed to the curing beds by a locomotive crane. Fig. 12 shows this plant, with the crane setting a steel form in position at the tower.

There were 3612 octagonal piles made, 20 to 40 ft. long, but 2647 of these were 30 ft. long. There were also 1142 rectangular sheet piles 24 and 28 ft. long, 932 being of the shorter length. Each pile was numbered, and a record was kept of the number and date of manufacture, so as to guard against any pile being driven before it was at least 30 days old. As a matter of fact, the pile driving was delayed on account of ice in the harbor, so that no trouble was experienced from green piles.

The piles for use were loaded onto scows by a locomotive crane and towed to the site, where they were driven by floating pile drivers. No particular devices were used to protect the head of the pile in driving, although several styles of driving caps were tried at first. Eventually the plan adopted was to use the ordinary cast-iron driving cap with an oak filler block and a few coils of rope. Most of the piles were driven without much hammering, but there were individual cases which required heavy driving. One 30-ft. pile required 440 blows of a 3000-lb. hammer falling 3 ft., and another required 840 blows. Neither of these piles suffered any appreciable damage, except at the top, which part would be embedded in the concrete superstructure. The piles drove to a very good line.

ORE-HANDLING MACHINERY

This equipment consists of four Hulett unloading machines and one conveyor bridge. The former travel upon the tracks upon the dock and the latter upon the tracks on the two walls in the stock yard, as described above. All these machines were built by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio.

Each unloader has a vertical arm or beam which is given a vertical motion by a walking-beam mechanism and carries at its lower end a grab bucket of 17½ tons capacity. The upper frame carrying the walking-beam and arm has a lateral travel upon the main frame, which latter travels along the dock. In unloading a vessel, the upper frame is run forward until the vertical arm is over one of the hatchways, and then the walking-beam motion lowers the vertical arm into the hold, where the operation of the bucket is controlled by a man within the arm. The reach or lateral travel is sufficient for unloading boats 65 ft. wide. The vertical arm (with its bucket) is then raised and carried back to discharge the bucket load into a 70-ton receiving hopper on the machine. From this hopper the ore is fed to a 50-ton larry car which can deliver it to railway cars on four tracks spanned by the machine, or into the ore trough behind the machine. The larry-car equipment includes scales for weighing the ore as it is delivered to cars. The unloaders are operated by electricity, 220-volt direct current being used. The motor equipment is as follows: 300 hp. for the beam or bucket hoist, 100 hp. for the trolley, 100 hp. for closing the bucket, 35 hp. for rotating the bucket, 150 hp. for the ore gate and travel, 150 hp. for the larry car, 35 hp. for the gates of the larry car.

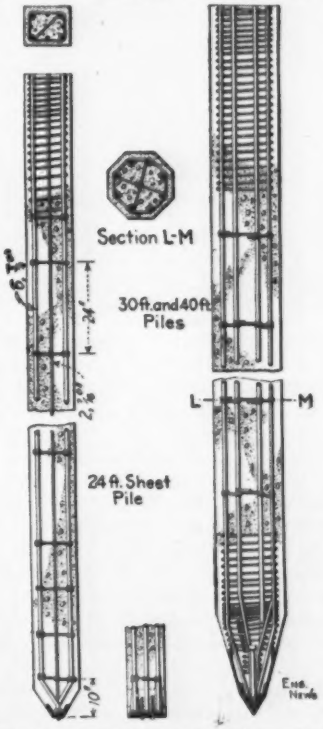


FIG. 11. REINFORCED-CONCRETE PILES AND SHEET PILES FOR DOCK AT CLEVELAND, OHIO; PENNSYLVANIA COMPANY

These machines are the largest ore unloaders of this type that have been built to date. They are very similar to those of the Lake Shore & Michigan Southern Ry. at Ashtabula, Ohio, but the buckets are of 17½ tons capacity (instead of 15 tons), the larry car handles a full carload (instead of half a carload, as on former machines), and the machines will

have somewhat higher speed owing to their larger motors. It is expected that each unloader will handle ore at an average rate of 600 tons per hour, and to reach that capacity they must work at a rate of 1000 to 1200 tons per hour during the earlier (and easier) stages of the work.

The ore-conveyor bridge will have a central span of 236 ft. (between track centers) with a 173-ft. cantilever at each end, giving a total length of 612 ft. for

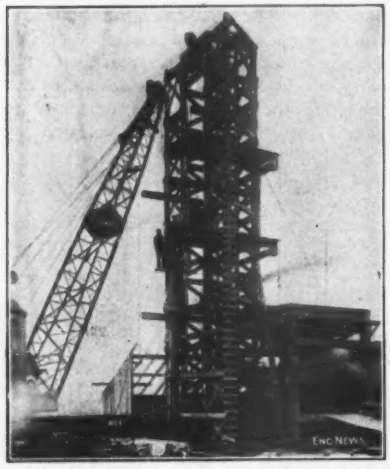


FIG. 12. PLANT FOR MAKING CONCRETE PILES

(The steel skeleton for reinforcement is placed in the steel form, which is held in a vertical position against the elevator tower; in the tower runs a bucket which dumps the concrete through a chute into the head of the form.)

the travel of the bucket, which has a capacity of 15 tons. The bridge is moved along its tracks by 75-hp. motors connected by gearing and shafts to the driving trucks of the main tower and the shear leg. The motors are controlled from the operator's cabin, suspended from the bridge at the main tower. The ore bridge is very similar to those previously built, with the exception of its device for weighing ore delivered to cars; this is of a double-hopper type, designed for continuous operation. The upper hopper receives ore at any time from the bucket, and serves simply as a receiving hopper which feeds the ore to the hopper immediately below it. The latter is mounted on scales which weigh and record the amount of ore delivered.

The 15-ton grab bucket handled by the bridge takes the ore from the trough (where it has been deposited by the unloaders) and delivers it to any one of the three stock piles.

In rehandling ore from these stock piles, the bucket discharges the ore into a 75-ton receiving hopper built into the framework of the main tower of the bridge. This hopper discharges into a scale hopper located over a loading track parallel with the bridge track, so that ore will be discharged directly from the scale hopper into railway cars. In Fig. 13 the ore unloaders are partly erected, spanning the space between the dock wall and rear wall, and having the deck cantilevered at the rear so as to extend over the ore trough. Two of the traveling concrete-mixer plants (Fig. 10) are shown, each with an elevator tower carrying chutes to deliver the concrete into the forms; the one at the left is on a track laid in the center line of the ore trough, the walls of which are clearly shown. At the right of the view are the falsework and derrick for the erection of the ore-conveyor bridge.

POWER PLANT AND BUILDINGS

At the west end of the property there will be a power house, machine shop and office building. The power house is 150x60 ft., with columns and floors of reinforced concrete, steel frame and brick walls. Outside of the building is a concrete coal bunker, crossed by a timber trestle approach for the hopper cars which dump their contents into the bunker. From this bunker the coal is taken by a grab bucket operated from an overhead track, and is dumped into a crusher located over steel hoppers through which the coal passes to the stokers. The ashes are dropped from the grates through a chute and are delivered to railway cars standing on tracks on the first floor. Water is taken from the lake through a 30-in. pipe to an intake well under the first floor; above this well is the hotwell, the overflow from which is discharged into the lake through another 30-in. pipe line. Power for the ore machinery is carried by cables through underground ducts to the main bridge wall and one wall of the trough; the current is carried along these walls by 85-lb. steel rails supported on cast-iron brackets, as shown in Figs. 3 and 9.

The machine shop, 60x70 ft., will be for repair work in connection with the ore-handling machinery. It will be provided with a 25-ton traveling crane, the runways of which will extend across tracks in front of the building, so that the repair parts can be handled directly by the crane between cars and the shop. The crane will be used also for handling the electric locomotives at the unloaders.

TRACK FACILITIES

The general arrangement of the track development is shown in Fig. 1. South of the ore piles is a group of tracks for empty cars, with a loading track for cars to receive ore from the conveyor bridge, as described above. At the east end of the property will be a group of tracks for loaded cars, so that there will be a direct movement to and from the ore dock.

There are four tracks beneath the unloaders, and 25-ton electric locomotives will be used for shifting cars on these tracks, the locomotives running on two tracks of 3½-ft. gage located between the standard-gage tracks as shown in Fig. 1. The two standard-gage tracks of each pair are spaced 18 ft. 6 in. apart, between centers. The locomotives will have contact shoes engaging conductor rails carried by insulators on the ties (between the rails). Each locomotive will be provided with side-pusher arms, and will handle cars on the two adjacent tracks.

In order to enable the Pennsylvania Lines to reach the dock it was necessary to cross the main line of the Lake Shore & Michigan Southern Ry., and, of course, no grade crossing could be permitted. The seven tracks of the L. S. & M. S. Ry. were raised 4 ft. and a double-track subway built beneath them at Hickory St. This subway has heavy side walls of reinforced concrete supported on concrete piles, and has also a center row of columns. The roof (or track floor) is of I-beams embedded in concrete. As only two of the L. S. & M. S. Ry. tracks could be abandoned at one time, the subway had to be built in sections, working from south to north, the overhead tracks being carried on a pile trestle during the progress of the work.

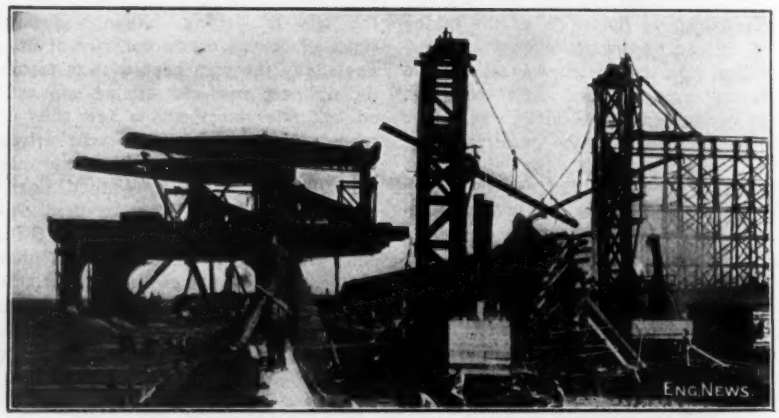


FIG. 13. ERECTION OF ORE UNLOADERS AND ORE TROUGH AT CLEVELAND, OHIO; PENNSYLVANIA LINES

Refuse Disposal, Toronto, Ont.

A condensation, with extended excerpts, of a report on the disposal of garbage, ashes and other refuse, both combustible and incombustible, at Toronto, Ont. The report was submitted late in 1911 by Rudolph Hering and John H. Gregory, New York City. The choice of methods of disposal narrowed down to (1) the incineration of garbage mixed with other and more combustible refuse, with no utilization of the heat of combustion, and (2) the treatment of garbage alone by the reduction process for the recovery of grease and of tankage for fertilizer base, and with the separate incineration of combustible refuse. The low price at which hydro-electric power is available in Toronto turned the scale in favor of the second alternative. If the salable portions of the combustible refuse were sorted out and sold and only the remainder burned, the estimates indicate a small profit from the combined operations of the reduction works and incinerating plants; otherwise there would be a slight yearly expense.

An interesting and valuable report on the best means of disposing of the refuse of Toronto, Ont., was submitted to G. R. Geary, Mayor of that city, by Rudolph Hering and John H. Gregory, Consulting Engineers, New York City, on Oct. 25, 1911. The report is notable for its analysis of the refuse-disposal problem of Toronto, which included a careful study of the relative merits of incineration and of reduction for the final treatment and disposal of the garbage, and also studies of the possible utilization of certain city wastes not included in the garbage class.

When the investigation was entered upon, it was supposed that an incinerating plant for burning the garbage and other refuse of the city would be recommended, with the utilization of the heat for electric power. During the investigation it was found that electric power was being delivered, or about to be delivered, in Toronto by the provincial authorities at so low a figure that it would not pay to install the plants necessary to utilize the heat resulting from incineration; in other words, it would be cheaper to waste this heat than to utilize it, in view of the low price for which electric power was available. Accordingly, it was recommended that in place of a mixed collection, three separate collections be made; and that the garbage should be taken to reduction works, the rubbish to incinerators and clean ashes used for land making or road foundations. The question as to whether the rubbish should or should not be sorted over to recover salable portions was left for future decision. The recovery of these salable portions would convert the net results of operating the reduction and the incinerating plants from a small deficit of $7150 to a revenue of $15,020, on the basis of a future population of 600,000 people.

The authors of the report make acknowledgments to R. C. Harris, Commissioner of Property and Street Cleaning of Toronto, and also to S. A. Greeley, who until recently was Civil Engineer and Superintendent of the Municipal Refuse Incinerator at Milwaukee, Wis. Acknowledgment is also made to I. S. Osborn, Engineer and Superintendent of the Municipal Garbage Reduction Works at Columbus, Ohio.

The city of Toronto has a land area of 29 sq.mi., being approximately 9½ miles in average length, East to West, and having an average width, back from the Lake shore, of about 3 miles. The city is located on a plateau which gradually rises from the lake to an elevation of about 220 ft. above the water. There are within the city limits 402 miles of streets and 121 miles of lanes. The population of the city by the census of 1911 was 336,240. It is estimated that the population will be 400,000 by the time the works are ready for use, and that the works proposed for construction should be capable of disposing of the wastes from a population of 600,000.

During the year 1910 there were collected 106,810 loads, or 64,086 tons, of ashes and rubbish. (All tons in this article are of 2000 lb.). During the same year 171,981 loads, or 154,781 tons, of garbage and rubbish were collected. The total amount of garbage, rubbish and ashes collected during 1910 was thus 278,791 loads, or 218,867 tons, equivalent to 0.55-ton per capita per year. The average cost of collection and disposal of the mixed refuse named was 37c. per ton mile. This was for collection and disposal, merely delivered at the dumps.

As an aid in determining the commercial value of the garbage of Toronto, tests were made of the reduction process as applied to this garbage at the works of W. Harris & Co. From 8823 lb. of garbage, which had been sorted from 11,075 lb. of mixed garbage and refuse, grease to the amount of 4.71% of the garbage was obtained. It was estimated by Harris & Co. that it would be practicable to recover 4% by weight of grease from the garbage of Toronto.

After reviewing the history of the introduction of improved types of garbage and refuse incinerators in the United States (beginning with the plant erected at Westmount, P. Q., a suburb of Montreal, in 1906, and coming down to the Milwaukee plant, erected in 1910, at which the cost of operation, including fixed charges, but exclusive of any revenue, the first three months of 1911 was $1.63 per ton, which can be reduced to $1.30 per ton by improvements in operation or even to a lower figure) the report takes up garbage disposal by reduction.

The reduction process, the report states, is a method chiefly in use in the larger cities of the United States where the garbage has been found sufficiently rich in grease to warrant its extraction. Mention is made of garbage reduction works at Boston, New York, Philadelphia, Baltimore, Washington, Buffalo, Indianapolis, Cleveland, Columbus and Chicago. The Cleveland and Columbus reduction works are the only ones under municipal ownership (for detailed figures of the results of these two reduction plants, see article by John H. Gregory in our issue of Nov. 30, 1911; the summary there given indicated that each of the plants was being operated at a profit).

As to nuisance from reduction works, the report states that it should be remembered that except for the Columbus and Cleveland works all of the reduction plants heretofore built have been erected and operated by private companies, whose primary consideration was profit. The reduction process itself is perfectly sanitary, provided proper works have been built and the works so built are properly operated, including the collection of gases which give rise to odors and the subjecting of these gases to a temperature of at least 1200° F.

On the subject of obtaining revenue from the miscellaneous rubbish of the city, experience at Buffalo, N. Y., is cited in the report. At this rubbish sorting and burning plant, the steam generated by the heat from the furnace runs the conveyor used in sorting the refuse, and the surplus heat is sold for use in the sewage pumping plant which is connected with the incinerating plant. The total revenue from the Buffalo plant for four years balanced the operating cost within a few hundred dollars, but the cost given, while including interest and repairs, does not include depreciation. (See Table I for detailed figures.)

Ashes and their disposal are briefly considered in the report. In most cities they are used for filling. In England and also in the cities of New York and Milwaukee, ashes contain as high as 25% of unburned coal, which is sufficient to warrant their incineration as an aid to burning garbage and refuse.

In arriving at a conclusion as to the most economical methods of treating the various classes of refuse, account must be taken of the effects of the adoption of any one method for a single class of refuse upon the cost of the disposal of other classes. Thus, if reduction is

TABLE I—OPERATING RESULTS, RUBBISH SORTING, UTILIZATION AND INCINERATING PLANT, BUFFALO, N. Y., FOR FOUR YEARS AND 1½ MONTHS, 1907-11

	Total
Operation:	
Pay roll	$104,677
Maintenance and repairs	23,491
Interest on bonds	8,920
Hauling ashes from plant	5,848
New construction	5,106
Total	$148,042
Income:	
Newspaper	$40,617
Mixed paper	75,756
Manilla paper	6,262
Rags	4,623
Flour bags	1,735
Charcoal bags	547
Magazines	51
Beer bottles	1,292
Mixed bottles	2,035
½-gal. bottles	70
Ammonia bottles	70
Tin cans	2,611
Scrap iron	542
Old rubbers, etc	65
Broken glass	20
Old shoe	112
Sundries	5
	$136,413
Deductions for moisture	1,934
Total net income, exclusive of sale of steam	$134,479
Steam furnished sewage-pumping station	12,894
Total receipts	$147,373
Population	.....
*Weight of material sold, tons	19,165
*Weight of rubbish burned, tons	28,335
*Total weight of rubbish handled, tons	57,500
Net income per ton of rubbish handled, exclusive of sale of steam	$2.34

*It is assumed that two-thirds of total weight of rubbish is burned and one-third sorted out.

chosen the garbage must be collected separately from the other classes of refuse and the latter remain for separate disposal.

Four projects are considered in detail in the report. We must ask our readers to be content with the comparative tabular summary, given as Table II, and with the final review and conclusion to the report, which we give as follows:

General Summary of Report

To briefly summarize what has been said in the foregoing pages, the first important point to be stated is that since the request for the present investigation was made, developments have occurred which materially advance the art and alter some of the original expectations. When the investigation started it was the opinion, both of the local authorities and of Mr. Hering, that incineration of the city refuse would be the most probable solution and that works for this purpose would be required.

Since then, electric power generated at Niagara Falls has been introduced in Toronto at such a low cost that it no longer pays to convert the heat developed by refuse incineration into electric or any other power, which elsewhere is the chief asset of such works. It is cheaper in Toronto to allow the heat generated to be wasted and to buy power from the Hydro-Electric Commission than to erect works and to pay the cost of converting the heat into power. The only practicable utilization of the heat from such incinerators in Toronto might be its distribution as steam or hot water in pipes for heating purposes during the colder part of the year. The return from such utilization, however, has not been valued in the present report because there now appears to be an insufficiently large or suitable market to pay the cost of installation.

Dropping, therefore, the usual revenue derived from steam, as obtained in Westmount and Vancouver, Canada, and in most of the cities of England, not to mention other countries, we find that the reduction process of garbage disposal comes prominently into the economical foreground. This process is used in most of the largest cities in the United States, and, whatever the numerous objections have been to this system in the past, due chiefly to their management for private profit, the objections can no longer be considered insurmountable, when we consider the recent experiences at the only two plants owned and operated by municipalities making public sanitation the first interest, namely, Cleveland and Columbus, Ohio.

We were, therefore, obliged to make a close and searching reëxamination and comparison of refuse incineration with garbage reduction as applied to the local authorities of Toronto. It was premised for both methods that the works should be so designed and operated that no sanitary danger and no offense or nuisance should arise.

No other methods of disposal, such as feeding swine with garbage, or burying it in trenches, have been considered, as they are not applicable to the conditions in Toronto.

The second important point arising is that among the several kinds of refuse, with which the city is obliged to deal, some are at present removed and disposed of without objection, such as street sweepings, stable manure, night soil and dead animals. The present report, therefore, deals only with the remaining classes, namely, garbage, rubbish and ashes.

The third important point that needed consideration is the fact that refuse incineration, comprising as it does the burning of garbage, rubbish and ashes together, has naturally connected with it their combined or mixed collection. Garbage reduction, on the other hand, demands a separate collection of at least this class of material and another collection, as well as a different method of disposal, of the other classes. We, therefore, had to consider both manner and cost of collection for each case.

The locations at which the collected materials are to be delivered depend on the method of final disposal. We find it possible to simplify the discussion of the collection by the fact that we could fix at the present time two locations adjoining the Grand Trunk Ry. tracks, and in the future a third one for incineration works adjoining the Canadian Pacific tracks, and conclude that these same locations would be the best also for the alternative project in which the rubbish alone would be incinerated. The garbage in this alternative project would be reloaded at these same points into cars and freighted to a location about 10 miles east of the city where a single large reduction establishment would be erected. By thus establishing the same points of delivery adjoining the railroad we could safely eliminate the cost factor of collection by debiting the reduction works with the cost of transporting the garbage to them by rail from the locations of the incinerators.

It must be admitted that the separate collection of the garbage in specially designed wagons and its delivery to the incinerators, and at more frequent intervals than required for the combined collection of all classes of refuse, will cost somewhat more than the latter. We have not been able to ascertain this difference accurately, but only sufficiently close to state that it does not alter the final conclusions as to the most economical method of final disposal. It will be advisable to remodel the collection system and also most of the wagons, yet this requirement, as above intimated, would obtain equally for both systems of final disposal.

Finally, it is suggested that the collection with wagons driven by electricity from storage batteries is being found economical and otherwise preferable in a number of cities, particularly in Europe. With the still more economical electric power in Toronto, this method of collection appears to be specially favorable and should be studied.

The fourth important point to investigate was the treatment of the refuse after delivery. If the refuse is mixed and collected by one class of wagons, incineration of the entire mass is the only practicable sanitary and economical treatment thereof. If the garbage is collected separately there is a possibility either of incinerating or of reducing it, both processes being frequently employed. If the rubbish is separately collected it can either be incinerated at once, or first have its salable parts picked out, thus diminishing the bulk to be burned. If ashes are separately collected they can either be utilized in part for incinerating the garbage or they can all be dumped at convenient and unobjectionable points. All of these methods of disposal are being practiced in well-conducted works without objection.

It was therefore necessary to study the conditions and cost: (1) of incinerating garbage, rubbish and ashes together, and (2) of reducing the garbage by treatment to salable ingredients and of incinerating the rubbish. In the first case enough ashes must be added to the refuse to facilitate its incineration at high tempera-

tures, and in the second case all of the ashes must be dumped on low ground or otherwise utilized.

Incineration of mixed or combined refuse is the only method successfully practiced in Great Britain. It is spreading on the continent of Europe and is also practiced both in Canada and the United States. The best furnaces can burn the refuse without offensive odors at a reasonable cost and their efficiency is being continually improved.

Reduction of garbage is today successfully practiced only in the United States, due to the rich character of American garbage, which is closely resembled in Toronto. This process is restricted to the larger cities, because the larger the plant the more economically can it be operated.

The two municipal reduction plants in Cleveland and Columbus, Ohio, the only cities where it was practicable to get full cost data, can be conducted without offensive odors. Garbage is thoroughly cooked and separated into water, grease and tankage, the two latter being salable products. The process is entirely sanitary and the odors produced can be entirely eliminated without difficulty. The bases and effluvia arising from the works can be made inodorous by passing them through a furnace and subjecting them to a sufficiently high heat.

The incineration of the rubbish alone, which is an integral part of a sanitary and complete system for refuse disposal when the garbage is reduced to grease and tankage, is conducted by plants similar to those required for the incineration of the entire refuse. Rubbish is often simply dumped when the garbage is reduced, and this disposition is at present the one practiced in Toronto. It is, however, both unsanitary and creates a nuisance and in large cities the practice is pretty generally being abandoned.

The rubbish is liable to contain discarded matters from sick rooms and hospitals and therefore to contain disease germs. Unless provision is made to exclude such dangerous parts by having special collection and immediate delivery to incinerators, the rubbish is the most unsanitary part of a city's refuse. Where these precautions are taken to guard against infected rubbish, objectionable materials are not apt to be delivered with the general rubbish. Therefore, a picking out of the salable materials has been practiced in several cities, because of the revenue derived therefrom. This was done on the Surrey side of the City of London. The practice was, however, abandoned in that city because it was felt that immunity against the possible occasional communication of disease could not be guaranteed. In Buffalo the rubbish is now being profitably picked over and no objection thereto is made.

We have prepared estimates of cost and also of revenue, should the Toronto rubbish be picked over, so that it will be practicable for your authorities to decide whether they desire to receive this revenue, as in Buffalo, or to relinquish it in favor of safer sanitation, as in London. When the population is 400,000 the annual saving of cost by picking is estimated at $15,970 for the incineration project and $13,070 for the reduction project. When the population is 600,000 the respective figures are $25,870 and $22,170.

Estimates of cost were made of four projects for a population of 600,000, for which population it was deemed proper to make the estimates. Two have been made for incineration of the garbage with a part of the ashes and the rubbish, both without and with prior picking over of the latter, and two estimates for reduction of the garbage and incineration of the rubbish, both without and with prior picking of the latter, as shown in Table III.

It will be seen that while the projects for reducing garbage and incinerating rubbish require a much greater outlay for construction than the projects for incineration of garbage, rubbish and ashes, being $287,500 more without equipment for picking, and $304,200 more with such equipment, the annual cost of operation, due to the return from the sale of products, is very much less. Without picking over the rubbish, the annual cost of operation with a population of 600,000 is $117,790 less, and with picking it is $114,090 less than the annual cost of incinerating together garbage, rubbish and ashes.

When we compare the cost of operation for a population of only 400,000, assuming for convenience that the first outlay is the same as for the larger population, we have the annual cost shown by Table IV.

These estimates show that for a population of 400,000, without picking over the rubbish, the annual cost of operation for the reduction project is $69,000 less, and with picking it is $66,100 less than the annual cost of incinerating both the garbage and the rubbish.

The above figures show conclusively that the project for incinerating both the garbage and rubbish of Toronto, in the near as well as the distant future, is materially more costly than the project for reducing the garbage and incinerating the rubbish. This circumstance, as already said, is due to the fact that the heat created by the incineration cannot be converted into electric power for the price paid directly for the Niagara power. It is also partly due to the absence of a market for the clinker, although even with such a market the balance still weighs greatly against the incineration of garbage and rubbish.

With reduction of the garbage and incineration of the rubbish, foregoing the profit to be derived from picking over the latter, the total outlay for construction would be $765,900 for a population

TABLE II. COMPARATIVE ESTIMATES OF THE FIRST COST AND ANNUAL OPERATING COSTS OF FOUR PLANS FOR THE DISPOSAL OF THE GARBAGE, RUBBISH AND ASHES OF TORONTO, ONT.

Project	Works	Estimated cost of construction	Estimated annual cost of operation for a population of 600,000, including fixed charges				Estimated annual cost of operation for a population of 400,000, including fixed charges			
			Gross cost of operation	Gross income	Net cost of operation	Net income	Gross cost of operation	Gross income	Net cost of operation	Net income
Project A										
Incineration of the garbage, rubbish and a portion of the ashes without utilization of the rubbish	Two 215-ton refuse incinerators	$478,400	$124,940	.....	$124,940	.....	$102,540	.....	$102,540	.....
Project B										
Incineration of the garbage, rubbish and a portion of the ashes with utilization of the rubbish	Two 195-ton refuse incinerators	$489,300	$166,570	$67,500	$99,070	.....	$131,570	$45,000	$86,570	.....
Project C										
Reduction of the garbage and incineration of the rubbish without utilization of the rubbish	One 240-ton reduction works	$538,200	$169,970	$210,000	.....	.....	$131,960	$140,000		
	Two 60-ton rubbish incinerators	227,700	47,180	.....	.....	.....	41,580			
	Total.....	$765,900	$217,150	$210,000	$7,150	.....	$173,540	$140,000	$33,540	
Project D										
Reduction of the garbage and incineration of the rubbish with utilization of the rubbish	One 240-ton reduction works	$538,200	$169,970	$210,000	.....	.....	$131,960	$140,000		
	Two 40-ton rubbish incinerators	255,300	92,510	67,500	.....	15,020	73,510	45,000	$20,470	.....
	Total.....	$793,500	$262,480	$277,500	.....	.....	$205,470	$185,000		

of 600,000. The annual cost of operation, including fixed charges, would range from $33,540 at the beginning for a population of 400,000 down to $7150 for a population of 600,000. If the rubbish is picked over the total outlay for the construction would be $793,500. The annual cost of operation, including fixed charges, would range from $20,470 at the beginning for a population of 400,000 to an annual profit of $15,020 for a population of 600,000. The annual saving in expense derived from picking, therefore, ranges from $13,070 to $22,170.

In view of the facts above set forth, we find that for the City of Toronto the reduction process for converting the garbage into salable products, the incineration of the rubbish and the utilization of the ashes for filling land or for other purposes, is materially cheaper than incinerating both the garbage and rubbish, together with a sufficient part of the ashes required to generate the necessary heat for a complete incineration of the organic matter.

Besides the financial side of the question, which it was the main purpose of this report to deal with, there are other sides which should be kept in mind, and therefore should be at least briefly mentioned.

The reduction system requires that the garbage, rubbish and ashes be separated at the house and placed in different receptacles, that separate collections of these three classes of refuse be maintained, that strictly enforced ordinances must be established to avoid any mixing of the several classes of refuse at the house, and, that to facilitate this enforcement, collections of the different classes of refuse should be made on different days.

When the interests of the householder are considered, the fact, well recognized in Europe, and here and there also on this side of the Atlantic, must be admitted that a single receptacle for all of the refuse is apt to encourage greater cleanliness about the premises, as well as greater simplicity in the servants' work and a better obedience to the respective city ordinances. With a separate collection, as in New York City, it cannot be denied that there is a constant and troublesome tendency, well recognized by the collection department, to throw rubbish and ashes into the garbage pail or garbage and rubbish into the ash pail. Similar experience is reported also from Boston and elsewhere. A mixed collection avoids the above troubles. The financial value of this condition must be determined by yourselves.

The reduction system further requires the city to enter into the business of selling grease and tankage in the best markets in the world, of entering into competition with other producers, and of taking the chances of the market. It is true that in Cleveland and Columbus this fact does not seem to have caused any disadvantages. In our comparison of cost, we have not taken the actual profits derived in those cities but have slightly reduced them for Toronto. The financial value also of this condition, namely, the undertaking by the city of a business enterprise on the present known facts, must also be estimated by you.

The unfortunate and unwarranted experience with most of the reduction works in the past and present, namely, the escape from them of offensive effluvia, may have the effect of a weighty opposition to the establishment of such a plant on the part of neighboring property owners. While there is no real ground whatever for such opposition at the works considered for the City of Toronto, and of which perhaps Columbus may give the best proof, yet it must also be left to you to estimate the financial value of such opposition.

On the other hand, to assist you in estimating these values, let it be said that experience in the United States has shown no lack of opposition to placing refuse incinerators in or near inhabited districts. This opposition is due to the nuisances generally caused by the older and unscientific designs for such incinerators, and are not inherent to the incineration method. In all of the latest designs for high-temperature furnaces, all offensive odors can be as readily prevented as in the latest designs for reduction works. Incineration plants are situated in built-up parts of cities in England and Germany without any objection, and on the American continent we can point chiefly to Westmount (Montreal), Richmond (New York City), and Milwaukee, Wis., as furnishing examples of odorless incinerators.

Again, an incinerator plant which reduces its annual cost by the sale of power and clinker also requires the city to sell both products. Steam is sold for heating or by conversion into electricity for power, and clinker is sold for making roads, artificial stone, concrete, etc. This feature is relatively favorable toward incineration. The steam or electricity in most cases is not sold in competition but is utilized for municipal works, for pumping or lighting, while the clinker is also used for public works; therefore the element of competitive business in such cases is largely eliminated.

Finally, and irrespective of cost, there is a difference between the two types of works in the collection system, for the one being more complex than the other, the relative value of which to you should also be estimated by you.

Both for sanitary and financial reasons, refuse disposal works must not only be properly built, but must also be operated with skill and care. Such works are as necessary a part of public works in a civilized community as are sewerage works. With skill and care both reduction and incineration works can be operated without objectionable results.

TABLE III.—CONDENSED SUMMARY OF ESTIMATED COST OF CONSTRUCTION AND OPERATION OF REFUSE DISPOSAL WORKS FOR A POPULATION OF 600,000

	Estimated cost of construction	Estimated annual cost of operation	Estimated annual revenue from operation
Incineration of garbage, rubbish and a portion of the ashes:			
(a) Without picking over rubbish	$478,400	$124,940	.....
(b) With picking over rubbish	489,300	99,070	.....
Reduction of garbage and incineration of rubbish:			
(a) Without picking over rubbish	$765,900	$ 7,150	.....
(b) With picking over rubbish	793,500	.....	$15,020

TABLE IV. CONDENSED SUMMARY OF ESTIMATED ANNUAL COST OF OPERATION OF REFUSE DISPOSAL WORKS WITH A POPULATION OF 400,000

	Estimated annual cost of operation
Incineration of garbage, rubbish and a portion of the ashes:	
(a) Without picking over rubbish	$102,340
(b) With picking over rubbish	86,070
Reduction of garbage and incineration of rubbish:	
(a) Without picking over rubbish	33,540
(b) With picking over rubbish	20,470

Recommendations

In Toronto the most material difference between the projects of incineration and reduction considered in this report, so far as the engineering aspects are concerned, is that of cost. We therefore recommend to you the adoption of the project according to which the refuse must be separated into three parts, to be separately collected, the garbage to be taken to a reduction works located east of the city and converted into salable products, the rubbish to be taken to incinerators located within the city and there burned, either without or with prior picking, and the ashes to be taken to points within the city where landmaking or road foundations are desired.

The Growth of the Los Angeles Water-Works under ten years of municipal ownership is summarized as follows by Burt Heinly, secretary to William Mulholland, chief engineer of the works, in the Los Angeles "Times" of Feb. 3.

gal.	59,000,000	943,000,000
Consumers	85,000	310,000
Service	23,000	65,000
Meters	319	45,000
Invested in meters		$450,000
Reservoir capacity,		
Fire hydrants	616	3,200
Annual income	$614,000 (est)	$1,175,000

Switch Indicators at Double-Slip Switches

Where intersecting tracks are connected by double-slip switches, and used in switching movements, some European railways install special signals or indicators to show which route is open. With two intersecting single tracks connected in this way, four routes are possible; that is, either one of the straight tracks may be clear, or either one may be connected with the other by one of the slip switches. It is very desirable to reduce the number of signals at these switches, which ordinarily would require four ground or low signals for each intersection; these would be very confusing in a large station yard. Two special forms of indicator signals for this purpose are described below. The information is taken from an article by Dr. M. Oder, professor of the Danzig Technical College, in the September number of the

Fig.1, The Jaeger Switch Indicator. Bavarian State Railways

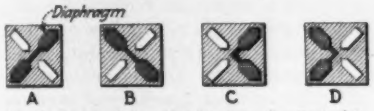


Fig.2, Signal of the "Elektrizitäts Gesellschaft" Prussian-Hessian State Railways

Eng. News

GERMAN SWITCH INDICATORS FOR SLIP-SWITCH CONNECTIONS (SHOWING FOUR INDICATIONS WITH ONE GROUND SIGNAL)

Bulletin of the International Railway Congress (Brussels, Belgium), being reprinted from the *Zeitung des Vereins Deutscher Eisenbahnverwaltungen."*

The Jaeger signal used on the Bavarian State Railways has a single fixed lantern with an opal or ground-glass panel in the front and back. In front of these plates are small jointed black arms which are operated from the switch connections and take the four positions shown in Fig. 1. The plain white (or illuminated) rectangle *A* indicates that the route is clear for the principal or main straight track; a black diagonal cross upon the panel, as at *B*, indicates that the route is clear for the intersecting track; a black V on the panel, as at *C* and *D*, indicates that the route is through one or other of the slip switches. One objection made to this is that it shows dark marks on a light background, while the general practice on German railways is to show light marks on a dark background.

This particular objection is overcome in the indicator signal used on the Prussian-Hessian State Railways, and shown in Fig. 2. This is made by the Allgemeine Elektrizitats Gesellschaft. The box or case has openings fitted with opal glass and over these openings move diaphragms operated from the switch and signal connections. The indications shown at *A* and *B* are for the direct routes on the two intersecting tracks, while those shown at *C* and *D* are for the routes through the slip switches, diverting traffic from one of the intersecting tracks to the other. When the switches are being moved, so that no route is clear, the diaphragms do not register exactly with any of the openings, so that no definite indication is given. This is termed a "disarrangement" indication, and means that no train must enter the limits governed by the indicators. The same indication will appear if the switch rails are not properly set, or if they are forced out by a train trailing through on a wrong track.

Another advantage claimed over the other form of indicator is that it shows definitely which of the two direct routes is clear. On the other hand, it has been said that its indications are clearly recognized only at shorter distances than those at which the Jaeger signal's indications could be distinguished. Furthermore, the latter signal has given excellent results in regular use for over 25 years, while the other has been used to a much more limited extent.

The New Ohio River Bridge of the Kentucky & Indiana Terminal R.R.

The construction of the new bridge of the Kentucky & Indiana Terminal R.R. Co. over the Ohio River at Louisville, Ky., is well advanced, but owing to delays it is probable that it will not be ready for service before the end of June. The new bridge is parallel with the old one, the center lines being 44 ft. apart. The two longest spans, across the Kentucky and Indiana channels, will be 620 ft. long, and there will be a 400-ft. draw-span.

There has been great delay in the erection of the superstructure, owing to unprecedentedly high water in the Ohio River, together with heavy floating ice. These conditions interfered with the placing of falsework, which was used on the two Indiana spans (now in place) and will be used for the span crossing Sand Island, separating the Kentucky and Indiana channels of the river. The falsework for this latter span is now practically completed, and the erection of steel will be begun in a short time, all the material being now on the ground. The remainder of the bridge (with the exception of one short span on the Kentucky side) will be erected by the cantilever method, but will not be of cantilever construction.

The new bridge is on the upstream side of the old structure, and as the center lines are 44 ft. apart, no change in the latter was necessary, except the highway (outside of the trusses) on the upstream side was abandoned for service and turned over to the contractor for the new substructure. The traffic was then diverted to the roadway on the downstream side of the bridge. The contractor had a concrete mixer beneath each end of the bridge. The concrete was raised to the highway and dumped into 2-yd. wooden cars, which were hauled to the pile sites by wire ropes operated from a specially designed hoisting engine. At the piers, the concrete was dumped from the cars into a 10-in. pipe leading to the forms. The maximum height through which the concrete was dropped was 127 ft. Some engineers thought that such a deep drop would cause such a separation of the material as to destroy its setting properties. However, the preponderance of judgment seemed to be to the contrary opinion and the method was tried. We are informed that it proved entirely successful, and that no separation of the materials has been experienced.

In this way the work of concreting was carried without interruption of the transportation of concrete due to high water. This avoided the expense of temporary tracks on falsework or the use of floating concrete-mixing plants. The substructure aggregates about 40,000 cu.yd. of mass concrete, with light reinforcement in the outer shell to guard against contraction cracks.

In the change of alignment and reduction of curves on the approaches it was necessary to remove a considerable portion of the old south approach. A temporary trestle was erected therefore, using wooden bents and I-beam stringers (the latter taken from material for the new bridge). To this structure the traffic was diverted, but in other respects the traffic on the old bridge has not been disturbed.

The consulting engineers are J. M. Johnson, Louisville, Ky., and J. E. Greiner, Baltimore, Md. The work is under the general direction of W. M. Mitchell, manager and chief engineer of the Kentucky & Indiana Terminal R.R. Co. The resident engineer in charge of construction is James B. Wilson; and the assistant resident engineer, in charge of drafting, is A. L. Hupe. All of the general and preliminary plans for the substructure and superstructure, together with the detail plans of the substructure, were designed and prepared in the office of the resident engineer. The detail plans for the superstructure were prepared by the American Bridge Co., which has the contract for material and erection. The contractors for the substructure were Foster, Creighton, Gould & Co., of Nashville, Tenn.

The Celilo Bridge: Oregon Trunk Ry.*

By Ralph Modjeski†

At Celilo, Ore., the Columbia River narrows to a width of approximately 2700 ft. between shores at high water, and there are high basaltic bluffs on either side, forming a narrow and picturesque gorge. At low water, the bed of the river consists of a number of basaltic islands separated by channels of rushing, roaring water. The main channel, near the Oregon shore, is about 300 ft. wide; the other channels vary in width and are quite narrow, some of them drying up entirely during low water. At high water, which happens once a year, all the islands are entirely submerged.

About two years ago when the construction of the Oregon Trunk Line‡ was begun, John F. Stevens (then president of that road) selected this spot, as well as another one about 10 or 12 miles further down stream (near The Dalles), as the two most favorable crossings to connect this road (following the Des Chutes River) with the Spokane, Portland & Seattle Ry., which runs along the north shore of the Columbia River. The writer was engaged about that time to assist in deciding on the crossing and to take charge of the construction of this bridge as well as all other structures along the Oregon Trunk Line. It was then decided to use the Celilo crossing, as providing not only the shortest haul for the Oregon Trunk Line, but the cheapest bridge.

The bridge as constructed consists of 2110 ft. of plate-girder spans, six riveted-through spans 230 ft. c. to c. of piers, one 240-ft. draw span, and one pin-connected through span over the main channel, 320 ft. c. to c. of piers. The north plate-girder approach forms a Y, so as to connect with the Spokane, Portland & Seattle Ry. in both directions. The total length of steel work in the crossing for either the eastbound or the westbound traffic is 3246 ft., and the total length of steel work (including both legs of the Y) is 4062 ft.

The number of islands and channels and their irregularity furnished quite a study for the proper selection of the crossing and several trials had to be made in the immediate vicinity before the final location was decided upon (Fig. 1). Unfortunately no favorable location could be found at this place which would enable the crossing of the main body of the river at right angles to the current at high water and therefore a slight skew had to be contended with. On the other hand, the location selected allowed an arrangement of the spans by which six of the through spans between the main channel and the beginning of the Y could be made of equal length, each pier being placed on rock above ordinary low water, making the foundation problem quite easy. Thus we have an unusual bridge, where all foundations of the river piers may be seen and examined each year. To speak more correctly, the foundations have been built above low water by nature, and it only remained for the engineer to place the piers on those foundations, thus saving all expensive foundation work. [This condition is shown by the profile, Fig. 1.]

The north pier of the main channel span is placed on a small island, and as this is near the deepest portion of the river there was some apprehension as to its stability. Three borings were taken on the island, and other borings on the opposite side of the channel near the water's edge. These borings extended

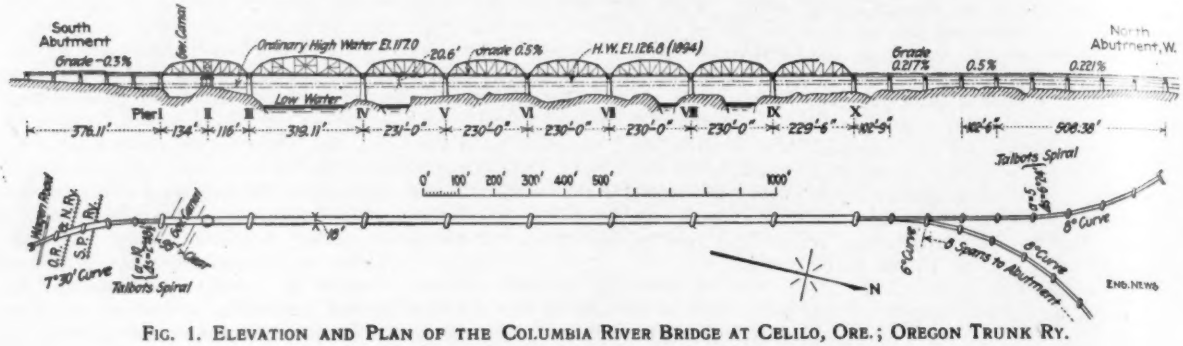


Fig. 1. Elevation and Plan of the Columbia River Bridge at Celilo, Ore.; Oregon Trunk Ry.
Ralph Modjeski, Chicago, Consulting Engineer.

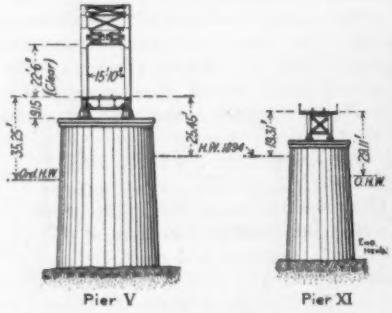


Fig. 2. Cross-sections of the Celilo Bridge, Showing Piers

Fig. 3. Cantilever Construction of Span No. 3, Celilo Bridge

*Abstract of a paper read before the Western Society of Engineers, Chicago, Jan. 8.

†Consulting Engineer, Monadnock Block, Chicago.

‡The Oregon Trunk Ry. was the subject of an article in Engineering News, Aug. 11, 1910.

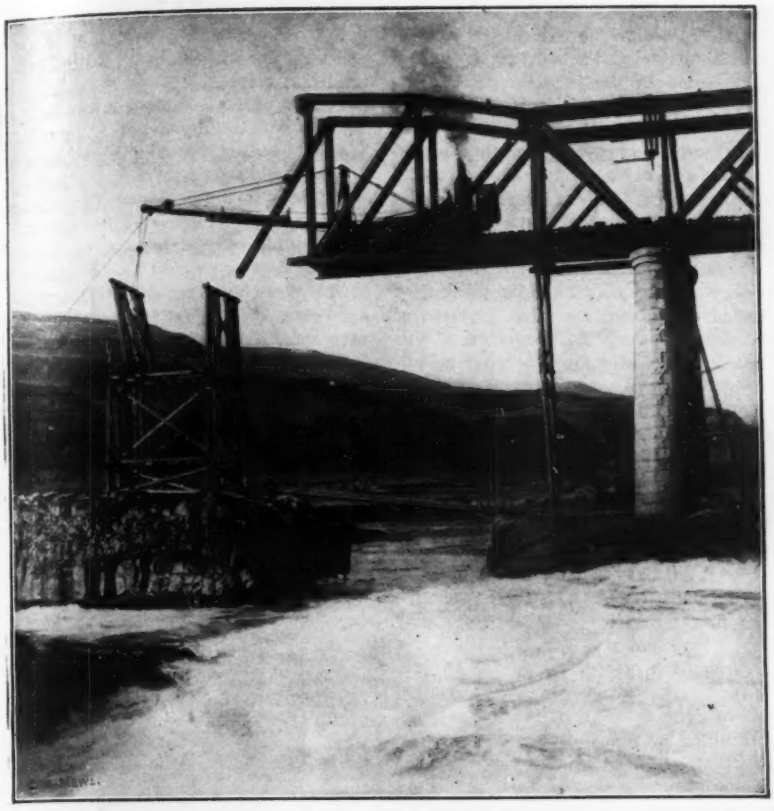


FIG. 4. CANTILEVER CONSTRUCTION OF SPAN NO. 7, OVER A NARROW CHANNEL, TO REACH FALSEWORK SUPPORTS ON THE OPPOSITE SIDE OF THE CHANNEL

(The derrick car is shown standing on the cantilever portion while erecting the falsework.)

200 ft. below low water. A stratum of sand (or what the writer believes to be cinders) approximately 4 ft. thick, was encountered in all borings at a depth of about 110 to 124 ft. below low water on both sides of the channel, but no overhang or undermining was shown. The behavior of the water in the drill pipe indicated that there is no communication with the main body of the water and is therefore below the bed of the main channel. At that time it was considered impracticable to take soundings in this channel owing to the swiftness of the current and inaccessibility of the location. These will be taken now from the span. The island was therefore considered safe enough to place a pier on.

It was at first contemplated to build all river piers of granite with concrete backing, but the cost proving to be excessive, these piers were built of concrete with granite nosings, belting and coping, while the approach piers on the south side are all of concrete (Fig. 2).

The design of the superstructure presents no features of unusual interest. It was proportioned to carry a loading of two 188½-ton engines followed or preceeded by 5000 lb. per lin.ft. for trusses; and of one 214½-ton engine with the same uniform load for the girders, floor system and hip verticals. Liberal allowance for impact and excess load from the down throw of the wheels provides a large margin for increase of train load in the future. The bridge is a single-track structure. The trusses are placed 18 ft. c. to c., leaving a horizontal clearance of 15 ft. 7 in.

Some of the shorter spans as well as the channel span had to be erected by the cantilever method, which made it necessary to make the spacing of trusses uniform for all other spans.

The six 230-ft. spans are riveted throughout. The channel span for convenience and speed of erection has been made pin-connected, eye-bars being used in diagonal and bottom chords. In reference to speed of erection, I know of no windier place than the Celilo gorge. Not only does the wind blow with extreme violence, but it carries with it the fine Columbia River sand, making it almost impossible at times to work outside. Goggles become a necessity when it is blowing. Erection work, if possible at all, becomes dangerous. It appeared to me that the shorter time the projecting cantilevers of the incomplete channel span were exposed to such gales the safer it would be. It was therefore deemed best to use pin-connected trusses for this span and to cut down the time for assembling as much as possible (Fig. 3).

Placing falsework in the narrow channels occupied by rushing water was out of the question. The spans were therefore so designed that they could be erected by cantilevering out over such channels until falsework on the further side could be reached. (This is shown in Figs. 4 and 5). Special erection devices were designed, consisting in temporary riveted tension members to be inserted between the hip joints of two adjacent spans. A span already erected could then act as anchorage to the one being erected. Wedges were provided in these temporary members, and on the piers of the channel span wedges were provided also at the shoes between the two spans. The wedges had a pitch of 1:6, and were lubricated with graphite and tallow.

This method proved very successful,

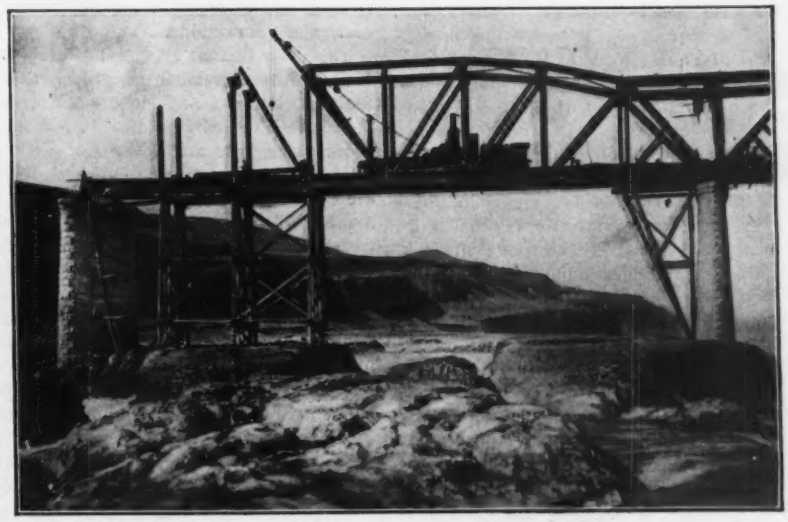


FIG. 5. ERECTION OF SPAN NO. 8, CELILO BRIDGE

(The central portion was erected as a cantilever across a deep channel, to reach falsework on the opposite side.)

especially in conjunction with the use of a derrick car for erecting the trusses. Before the erection of the trusses was begun I was strongly prejudiced in favor of the traveler method of erection, but as the work progressed and as the derrick car was being employed I became more and more convinced that for moderate spans the traveler will soon be superseded by the derrick car or a similar tool. The last four 230-ft. spans were erected with two derrick cars, one setting out falsework and the other following and erecting the steel. From the nature of things the falsework could not be built much ahead of the steel without great expense in handling timber across the channels. The time consumed in the erection of the six 230-ft. trusses, from the placing of the first bent of falsework, was 100 days, or an average of about 16½ days to the span. This, of course, includes falsework, and also includes many windy days in which no work could be done. The first span took about three weeks to assemble, while some of the other spans took considerably less than 16 days.

The 320-ft. channel span was the last to be erected. The south approach girders and the draw span were erected before all of the 230-ft. spans were connected up. It was contemplated to erect the south half of the channel span by means of a traveler, and then to take down this traveler, move it across the channel and erect it for the north half of the span. Stringers were suspended crosswise at panel points to carry the traveler track outside of the trusses. Several panels of the south half of the span were erected in that way.

But just before the erection of this span was commenced, an error in the assumptions in the calculations of the erection stress was discovered, affecting especially the top chord of the draw span. This resulted in a change of the method, and strange to say, hastened the completion of the work by at least two weeks. This error was caused by underestimating the overturning load of the traveler due to the high winds. The results, taking into account all wind stresses, showed a stress of 24,000 lb. in tension in the end panel of the draw-span top chord, also other stresses slightly above 20,000 lb. While theoretically the former stress is well within the elastic limit (which in this material is not less than 35,000 lb.), practically it was too high.

Erection was started therefore by means of the traveler, with the understanding that it would not go out as far as originally contemplated, and that many of the less important members in the four center panels would be left out and not put in place until after the removal of the traveler. In the meanwhile the mind of the contractor's foreman, Mr. Kelly, was working and as a result the traveler was taken down and not used at all on the north half. Instead, the erection was completed with a derrick car in a most successful way. The saving in time is represented by the time required to remove the traveler, ship it across the river, and rebuild it; or even if two travelers had been used, the time saved would have been considerable. This is another defeat for the traveler method in favor of the derrick car. The center connection was made by slacking the wedges in the temporary top chords, the bottom-chord connection being made first. Wedge adjustment was also provided at the shoes between the north end of this span and the adjoining one; but no adjustment was deemed necessary at the south end, which simply butted against the shoes of the draw span.

The progress of the work was as follows: the engineers' camp was established in February, 1910; the ground for foundations was broken July 9, 1910; the substructure was completed on June 5, 1911, so that the total time consumed by the substructure was eleven months. The first steel (in the shape of girder shoes) was erected April 20, 1911, and the first train crossed the bridge on Jan. 4, 1912. The time consumed in erection and in getting the track ready for traffic was 8½ months. The total time of construction, from the breaking of the ground to the opening of traffic, was 17½ months.

A New Type of Service-Box for Water and Gas Pipe House Connections

Probably the most common type of service-box in use is the telescopic pattern, consisting of three parts: a base or lower section, an upper section fitting into or over the lower section, and a cover. The bottom of the lower section is open and enlarged to inclose the curb cock and connections.

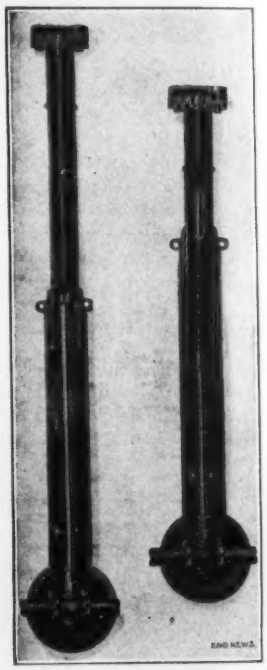
The open bottom around the cock, of course, has a number of objectionable features, for mud and loose dirt are liable to work in or be washed in, and thus prevent access to the valve.

The advantages of a closed service-box are thus evident, and there are already a number of types on the market. These usually consist of the parts previously mentioned, with the addition of a fourth casting, on which the valve box proper rests, and which is generally provided with clamps for keeping the valve cock in an upright position in the box.

The service-box shown in the accompanying illustration is an improved type of closed box. Although of the usual telescopic pattern, the lower section of the cylindrical upright is cast in two longitudinal sections, with grooved joints, and bolted together at top and bottom. The part inclosing the valve is of a cylindrical shape, being round in the longitudinal section shown, and rectangular in a section at right angles. The casting is provided with two lugs, which hold the valve rigidly in place.

This service-box is made in two styles; one in which the cock is turned by a long bar wrench, and the other provided with a telescopic rod reaching to the box cover, so that the cock may be operated with a small key wrench. The two covers are securely locked on by special nuts, which are released by a single twist of the same key wrench which operates the valve cock. In the style having the valve rod, it is not necessary to remove the inside cover.

To protect the valve cock in event of the long bar wrench being dropped into the box, a plate having an irregular opening, the shape of the wrench head, is provided just above the valve; through this the wrench will slip only when correctly placed.



CLOSED TELESCOPIC SERVICE-BOX FOR WATER- AND GAS-PIPE CONNECTIONS

This new style of service box is manufactured by the S. E. T. Valve & Hydrant Co., 50 Church St., New York City. The same company is also about to put on the market a box of similar design which will be made waterproof by packing, a type advantageous in localities where the ground water rises high enough to endanger the closing up of the valve box by ice.

The Highways of Bulgaria have been classified by P. Karakulahoff, chief of Roads and Bridges of the Kingdom, as 2070 miles of good roads, 1757 of middling roads and 1529 miles of bad roads. These figures were for the close of 1910.

A Self-Dumping Mine-Car Haul at the Burnside Colliery, Pottsville, Penn.*

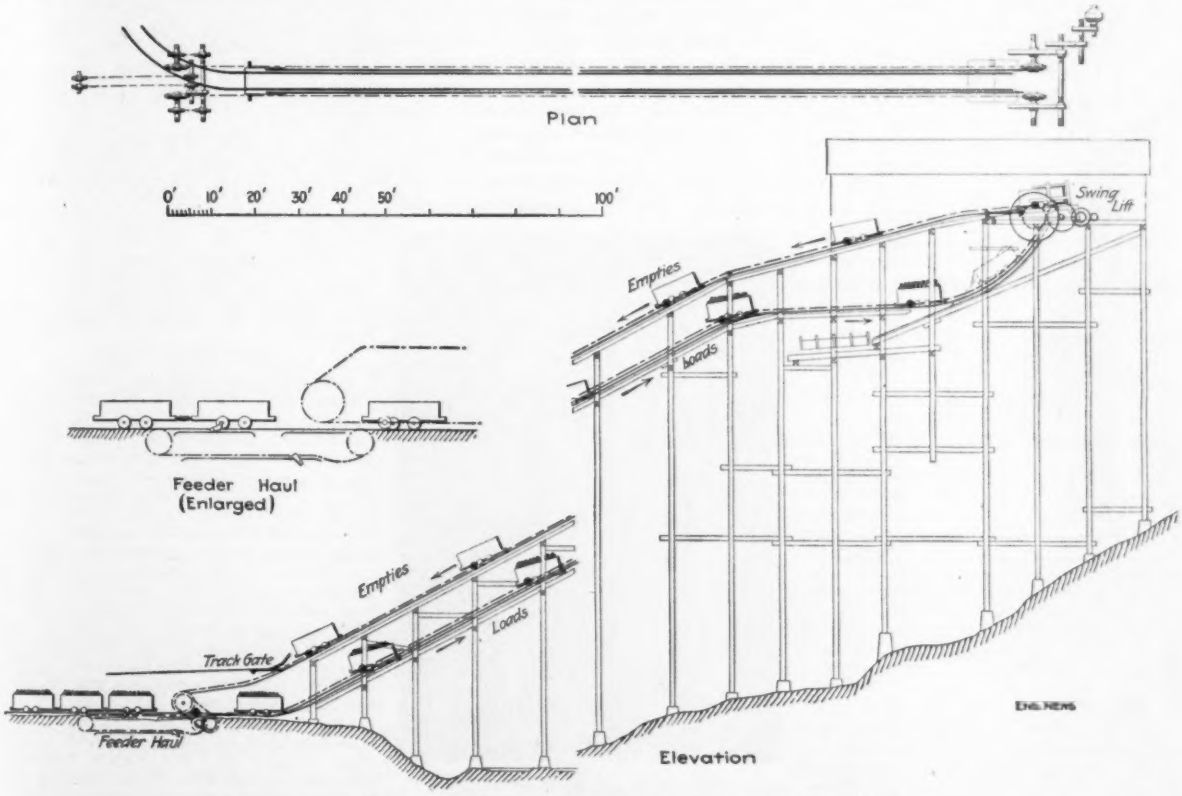
The Burnside breaker of the Philadelphia & Reading Coal & Iron Co., at Pottsville, receives coal from three openings, the Burnside shaft, Burnside drift, and Sterling slope. Tracks approach the breaker from three directions around curves of different degrees. The limited space for track storage of waiting mine cars demands speedy handling of the loads and return of the empty cars to keep the several workings clear at all times. On the old haulage system, two loaded cars were elevated for dumping while two empties were lowered on a parallel track—the scheme found at many mines.

In order to increase the unloading capacity, the system shown in the accompanying figure was installed. It is essentially a bucket conveyor; there is an endless chain, but the permanent buckets are replaced by the mine cars taken up from the bottom of an incline.

The whole arrangement may be understood by reference to the accompanying figure. There are two parallel endless chain belts passing over sprockets at either end of two tracks, one of which is above the other. Traveling with the two chains and extending from them out over the tracks sufficiently to engage with the rear wheels of the mine cars are short bars or pins. These bars first lift the rear end of a loaded car up sufficiently to prevent spilling coal on the 30% grade of the incline and then force the car to ascend. As a car nears the top the end-door catch is released by a trip beside the track and the car empties as it ascends farther. It next goes onto the arms of a swing lift, or hinged-track gate. The car and one end of the lift are raised together to the upper track as the chain belt moves along. After the projecting cross-bars have gone over the upper sprocket they are in front of the now empty car, which then descends by gravity, but held back to the speed of the chain belt. When the car leaves the swing lift this is released so that it can drop to receive the next car.

When a car reaches the botttom of the upper track of the incline, it meets a balanced track gate, which is normally open, and there stops. The bars are carried along, however, and ride over the gate drawing this down to close the gap in the upper track and to switch the cars away to the workings. The pair of projecting bars is thus released from the car, and then passes along down the track over the bottom sprocket to pick up another load.

To properly feed the loaded cars onto the incline, an auxiliary feed haul is arranged at the bottom and geared in with the main chain. This smaller haul consists of two parallel chain belts carrying two swinging catches or dogs. Short cam tracks hold a dog erect, drop it and raise it again as the chain travels along near the feeder track. As a train of loaded cars comes along, the head car is first caught at the rear axle by a raised dog. The car (and train) is pulled along till the dog loses its grip (at the gap in the cam track). Then, while the train is stationary, a man pulls out the coupling-pin between the leading and second cars, freeing the first one from the the train. This leading car is pushed along by the car immediately back, which is soon engaged by the approaching erect dog above the cam-track section. In turn, the second car comes to a stop opposite the gap in the cam track for uncoupling from the rest of the train. The first car has been advanced, in the meantime, so that when the dog is raised again by the second section of cam track the car is engaged and pushed onto the incline approach where the projections on the main chain can engage it.



DIAGRAMMATIC PLAN AND ELEVATION OF GREEN SELF-DUMPING CAR HAUL

(Made by C. O. Bartlett & Snow Co., Cleveland, Ohio.)

*From information furnished by H. H. Bighouse, chief engineer of the C. O. Bartlett & Snow Co., Cleveland, Ohio.

Only two men are needed in the operation of this haul—the one who pulls the coupling-pin at the feeder track and the one at the dumping track near the top of the haul. The latter has little to do, his duty consisting (1) in watching the dumping of the cars to see that the machinery operates smoothly and (2) in starting up the motor (which is located near the upper sprocket) when it has been stopped by opening one of the several safety switches, located around the haul. The power can be thrown off at any of these places, but it can be restored only at the top and then only after all the other safety switches are closed.

From 120 to 130 four-ton cars can be unloaded and returned per hour, which provides a margin for various delays and still accommodates the capacity of the workings. The three workings which feed the colliery have a capacity of 850 cars a day. The breaker works 8½ hours.

The haul has been equipped with recording meters which show the times of starting and stopping, the duration of waits, the number of loaded cars carried up and the number of failures to carry a load; from these records the location of delays is evident and the cause may be traced.

The Recovery of Waste Metal in 1910 has recently been reported by the U. S. Geological Survey. The figures of the accompanying table show the recovery of secondary (This term is used to distinguish from "primary" metals won from ore.) metals from scrap, sweepings, drosses, etc. There was an increase over 1909 occasioned partly by increased business activities and a tendency toward greater conservation of wastes, and also in part by the fact that during this year the Survey made a more extensive canvass of the sources of secondary production.

The production of copper from secondary sources in 1910 was equal to about 17% of the domestic consumption of new copper. The secondary lead produced was equal to 11.5% of the lead refined in the United States. The secondary zinc, including that found in waste brass, equalled 23.2% of the total production of primary spelter in the United States. The secondary antimony, recovered almost wholly in alloys, shows a large increase and, as the domestic antimony ores are comparatively small, the secondary recoveries are the only important domestic sources. A similar condition exists in the production of tin in the United States.

Metals	1910 Short Tons	1910 Value
Secondary copper, including that in alloys other than brass	51,000	$12,954,000
Remelted brass	62,000	13,032,400
Secondary lead	29,384	4,868,400
Recovered lead in alloys	25,939	
Secondary spelter	41,223	4,744,300
Recovered zinc in alloys other than brass	2,709	
Secondary tin	7,217	9,481,800
Recovered tin in alloys	6,686	
Secondary antimony	9	444,600
Recovered antimony in alloys	2,770	
Total value	.....	$45,525,500

Walter A. Post*

Walter A. Post, who died in Newport News, Va., on Feb. 12, was born at Kingston, N. Y., Jan. 7, 1857. His father was Thomas and his mother Francis A. (Winnie) Post. Both lines of his ancestry were English.

His early education was obtained at private schools and in the public schools of Rensselaer, N. Y.; later he completed his studies under private tutors.

Mr. Post's first engineering work of importance was in the employ of E. I. White, contractor for the terminal improvements of the Chesapeake & Ohio Ry., at Newport News, Va. He remained in this position for the ten succeeding years, a period which also saw the inception of the great enterprise with which he was soon afterward associated.

His ten years of experience in Newport News on railway terminal work peculiarly fitted him for engineering work

WALTER A. POST

in connection with the construction of the shipbuilding works, then just begun for the Newport News Shipbuilding and Dry Dock Co. This company acquired the services of Mr. Post in 1890, and as its civil engineer he had charge of the erection and equipment of the entire plant, a work so satisfactorily carried out that in 1898 he was made General Manager of the company.

From this year may be said to date the beginning of the new United States Navy, now the second largest in the world, and of the 37 first-class battleships built or now building, Mr. Post's company has built eight, and is at work on the ninth, the new "Texas" of the Dreadnought type. Under his direction the company expanded into one of the greatest shipbuilding plants in America.

A year ago, in February, 1911, Mr. Post was elected President of the company, of which he had also become a director. He was also President of the Old Dominion Land Co.; the Newport News Light & Water Co.; the Citizens' Railway, Light & Power Co.; a director of the Newport News & Old Dominion Railway & Electric Co., and President of the First National Bank of Newport News.

Mr. Post was elected a member of the American Society of Civil Engineers in 1893, and was a member of the Society of Naval Architects and Marine Engineers, and a fellow of the Royal Astronomical Society of London, England. He also belonged to the Engineers' Club of New York City, and the New York Railroad Club.

From his work in building and equipping a great modern shipbuilding plant, Mr. Post attained a place in the front rank of engineers; but his most notable achievement was the direction of the company's subsequent operations and the formation and management of its organization as General Manager and President.

*Contributed by request by Chas. F. Bailey, Chief Engineer, Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

The Production of Iron Ore in this country is noted in a preliminary statement of data from the Thirteenth Census recently published by the U. S. Census Bureau. It includes a summary for the years 1902 and 1909, prepared by Mr. I. A. Hourwich, Expert Special Agent on Mining. To avoid duplication of work, the U. S. Geological Survey which collects annual statistics of production and the Bureau of Census have coöperated. In the accompanying table it is seen that there are increases in all items for 1909 over 1902 except for number of mines. "Quantity and Value of Products" represent shipments to market, or ore used in blast furnaces owned by the same operators; these figures do not include the quantity and value of ore mined but not not shipped or used. The item "Cost of Materials" includes amounts expended for explosives, lumber for repairs and mine supports, renewals, repairs, tools and items of such nature. Fuel, rent of power and heat, and freight paid on materials are also included. The increase in cost is not to be taken alone but in comparison with increases in amount and value of product.

IRON ORE PRODUCTION IN 1902 AND 1909.

	Census—1909.	Per cent. of increase, 1902-1909.
Number of mines	483	—8
Capital	$299,350,000	....
Total expenses, including cost of development work	$74,072,000	79
Salaries	$2,979,000	41
Wages	$29,731,000	38
Cost of materials used	$17,230,000	91
Rent and royalties	$15,175,000	133
Taxes, contract work and sundry expenses	$8,957,000	311
Products sold or used:		
Quantity, long tons	50,521,000	42
Value	$107,000,000	63
Number of officials and clerks	2,647	10
Average number of wage earners	47,000	21
Primary horsepower	350,000	192

Note—A minus sign (—) denotes decrease.

Rock Crushing Plant, Kensico Dam

By Samuel W. Traylor*

The Kensico Dam for the new Catskill water-supply for the city of New York is to be built of cyclopean concrete masonry utilizing the quarried and crushed stone available near the dam site. To prepare this crushed stone the contractor is now installing the very large stone-crushing plant described below. This plant has an estimated maximum capacity of 500 cu.yd. per hour. The initial crusher, of the jaw type, has a clear opening of 5x7 ft., and will take the run of quarry product, making possible, according to the builder, a considerable saving on quarrying and crushing costs over the largest single unit gyratory plant. Not only on account of its size but also because it is built merely as a construction plant is it interesting.

*Traylor Engineering & Manufacturing Co., 30 Church St., New York City.

The Kensico Dam, which is being built across the bed of old Lake Kensico, in Westchester County, New York, is to be used to create a storage reservoir in connection with the new Catskill water supply of New York City, and will retain sufficient water behind it to ensure a supply of about 45 days to the city, in case of an accident to the system between Lake Kensico and Ashokan. The dam itself is to be built of cyclopean masonry faced on its upstream side with concrete blocks and on its downstream side with cut stone, and will contain over 1,000,000 cu.yd. of masonry. The geological formation of the valley, which at the point of the dam is 1900 ft. wide, is rather peculiar, being eroded out of a vein of dolomite, about 400 ft. thick, which lies between the gneiss of the easterly hill and the mica schist of the westerly hill, and at the point of contact there is the badly decomposed and disintegrated condition of the rock naturally to be expected. This will make necessary an excavation of about 130 ft. below the present surface of the valley to ensure a dependable foundation, and at this point the total height of the dam will be about 300 ft.

For the construction of this dam the contractor, H. S. Kerbaugh, Inc., is now installing a very large rock-crushing plant, which will be located near the dam site and will take the rock directly from quarry and crush it to the desired size for the concrete work.

Quarry and Equipment

This quarry and plant are located at Valhalla, in the suburbs of White Plains, N. Y., on the New York Central R.R., about thirty miles from New York City. The quarry extends along the edge of a granite reef or ridge 3000 ft.

The pneumatic drills used in quarrying are of the very largest made for this purpose, having a capacity for boring a 5-in. hole to a depth of 20 ft.

There will be used four 90-ton, 4-cu.yd. steam shovels in loading the rock into the quarry cars.

The transportation facilities consist of four 40-ton locomotives, each handling a train of 15 to 20 cars, each car having a capacity of 8 cu.yd.

As the trains are loaded by the steam shovels at the quarry they are hauled into the crushing plant, where the cars are quickly dumped by an ingenious device and the rock discharged into a chute leading directly to the initial crusher. The train is then hauled through the crusher building and returned to the quarry over a separate track.

Crushing Plant

The layout of the crushing plant is shown in Fig. 2. The progress of the rock through it is as follows: Quarry rock is brought in on the high-level tracks and is dumped into the initial 5x7-ft. crusher, which reduces the rock to a size of 9 in. and finer. It then passes over a grizzly with 4½-in. openings, the undersize or through product going directly to the elevator, while the oversize is run through the second crusher with an opening 3x6 ft., reducing it to 4 in. and finer. This product, with the undersize from the grizzly, then goes to the elevator and is raised to a 7x30-ft. screen. This screen is so designed that all material ¼ in. and finer is removed for a sand product and stored separately, while the coarse aggregate, or stone between ¼ and 2½ in., is distributed by a 30-in. conveyor into a 10,000-ton storage bin, located at the lower end of the plant directly over the outgoing railway tracks. The oversize from the screen goes to a small bin, which is equipped with a 28-in. steel-pan feeder and is delivered uniformly to a heavy-duty 60x30-in. crushing roll; the product from this roll being returned to the same elevator and screen.

The storage bins are so constructed with bottom- and side-discharge gates as to permit of loading standard-gage cars running under the bins as well as at the sides, preventing any congestion at this point and making available the full storage capacity of the bins by reason of the many points from which the product is discharged.

From this brief description the simplicity of design and economy in operation will be noted, as well as the small number of individual machines required for so large a capacity. The equipment of the crushing plant is as follows: One jaw crusher, with a clear opening of 5x7 ft.; one jaw crusher, with an opening of 3x6 ft.; one continuous bucket elevator, with buckets 42 in. wide by 18 in. deep by 19 in. projection; one all-steel 7x30-ft. revolving screen; one 60x30-in. heavy-duty crushing-roll.

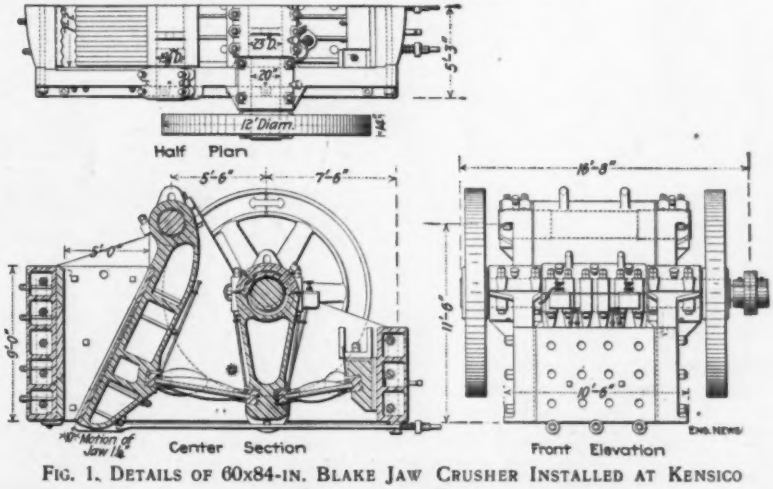


FIG. 1. DETAILS OF 60x84-IN. BLAKE JAW CRUSHER INSTALLED AT KENSICO CONSTRUCTION PLANT

It will be seen that this plant presents interesting features, from the fact that it would require not less than nine gyratories, if that type of crusher were used. Even though a No. 21 gyratory were used as the initial crusher, all rock coming from the quarry would have to be broken to a size of 3 ft. or smaller before it would enter the crusher. The necessity of breaking the quarry product to 3 ft. and smaller adds materially to the cost of operation of a gyratory plant. The initial crusher, as designed, however, will

take any piece of rock that will ordinarily come from the quarry, and this greatly reduces the cost of quarrying, handling and crushing.

The matter of repairs is of small moment in this plant, as it is estimated that all wearing parts will last for two years or more in continuous operation without renewals.

Some of the novel features of this plant are the trackage arrangements and the facilities for loading and unloading all products during construction, there being provided a standard-gage track along the upper side of the plant, with a crane running over this track and into the crusher building, facilitating the removal and placing of the heavy machinery directly from the railway cars. When the plant is completed this same track will be used for returning the empty cars to the quarry. The crane is so located that it may be used to advantage, if necessary, for removing pieces of rock more than 7 ft. in size which may have gotten into the plant by accident, and so avoid any possibility of congestion from this source.

There are also two main delivery tracks running directly through the building, and heavy chutes extending from both tracks to the initial crusher. Only one of these tracks will be used at a time, the other being purely an auxiliary to be used in case of mishap or obstruction, when it may be put into commission, thereby making it unnecessary to close down the plant. This track equipment is so arranged, also, that the initial crusher can be temporarily closed down and the rock fed directly to the second crusher, this being especially desirable should the rock from the quarry be running in small sizes, such as would enter the second crusher without difficulty, thus not only saving the large crusher, but considerable expense in the matter of power, and this arrangement also permits, of course, repairs or changing of wearing parts on one machine without the necessity of closing down the whole plant.

UNLOADING DEVICE—There is provided a special unloading device which is supported by the crane extending over the large crusher, delivery tracks and chutes. This device consists of an air lift, the cylinder being 20 in. in diameter, to work under an air pressure of 80 lb., and having a lifting capacity of 10 tons. As the cars pass in front of the chutes, one man can quickly dump them by hoisting one side of the car, making a very economical arrangement.

LARGE CRUSHER—The large or initial crusher in this plant has a jaw opening of 5x7 ft., and will easily take a stone weighing 10 tons and reduce it within 1 min. This crusher is constructed of cast steel throughout, with the exception of the large flywheels, and has a total weight of 450,000 lb. The flywheels are 12 ft. in diameter and weigh 15 tons each. The swing-jaw shaft is 20 in. in diameter and weighs 6 tons, while the pitman shaft is 24 in. in diameter in the pitman and 20 in. in the bearings, and weighs 8½ tons. The swinging jaw of this machine is 13 ft. in length by 7 ft. wide, and weighs 73,000 lb. The wearing plates are made entirely of manganese steel in sections which are interchangeable, so that the different sections may be changed about from time to time, thereby greatly increasing their life.

All bearings are water-cooled, and compression grease cups 12 in. in diameter are provided as an integral part of such bearings for lubrication.

The overall length of the crusher is 24 ft., the width 15 ft., and the height 13 ft. A better idea of the construction of this machine may be obtained by referring to a sectional view, Fig. 1.

SECOND CRUSHER—The second crusher has an opening of 3x6 ft. and is of the same type as the large one, with an overall length of 13 ft., width 13 ft., and height 9 ft. The swing-jaw shaft is 12 in. in diameter, and the pitman shaft 14 in. in the pitman and 12 in. in the bearings. The flywheels are 8 ft. in diameter by 12 in. face, and have a peripheral speed of 5000 ft. per min., being operated at a speed of 200 r.p.m. The total weight of this machine is 210,000 lb.

ELEVATOR—The location of the plant is such that it requires the raising of all product, after passing the second crusher, to the screen. The elevator used is of the continuous type, each bucket being 42 in. long, 18 in. deep and 19 in. projection. These buckets are fastened to

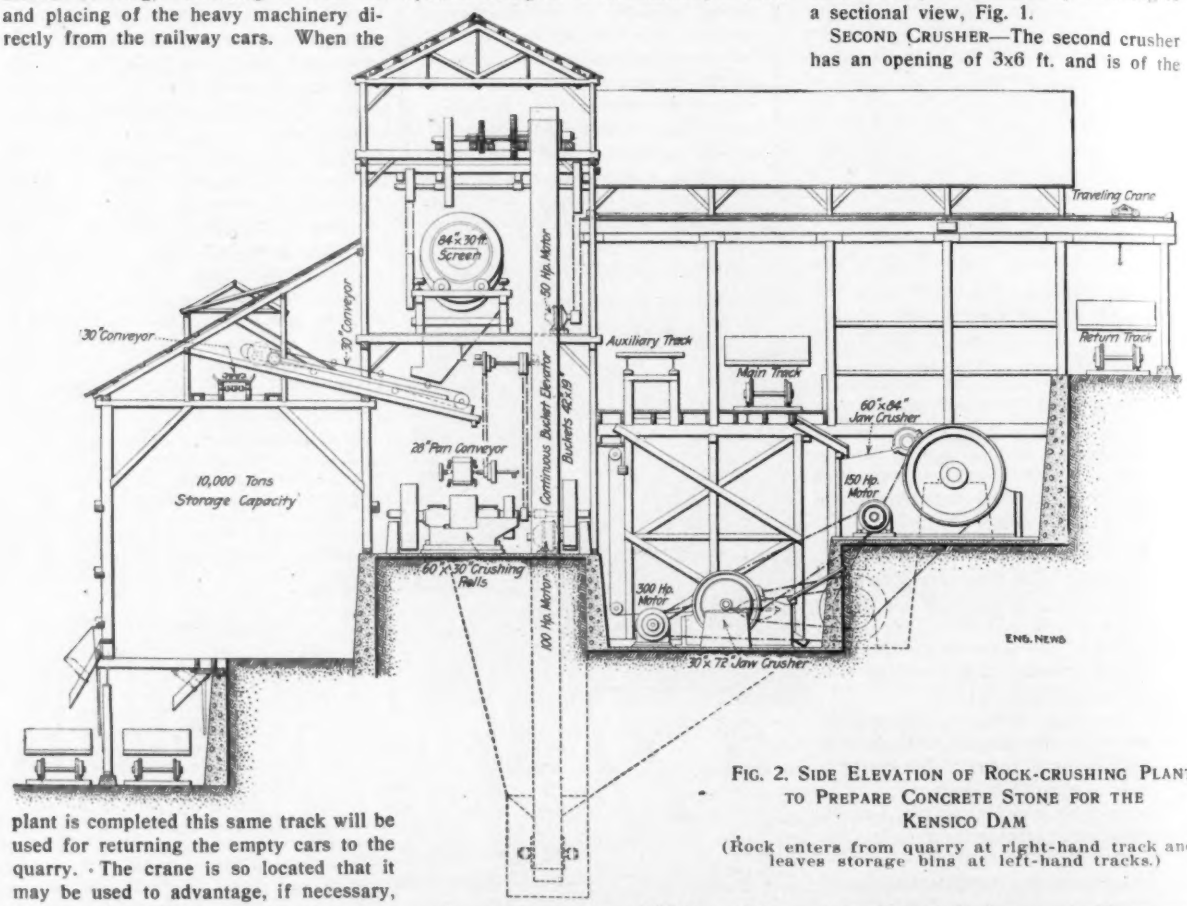


FIG. 2. SIDE ELEVATION OF ROCK-CRUSHING PLANT TO PREPARE CONCRETE STONE FOR THE KENSICO DAM

(Rock enters from quarry at right-hand track and leaves storage bins at left-hand tracks.)

a shaft, the ends of which are equipped with steel-bushed rollers. These rollers travel on a 30-lb. rail made fast to runway timbers. Each bucket is provided with a double link bar on each side, made of ½x3x18-in. bars. The rollers are lubricated by means of compression grease cups suitably connected to the end of the roller shaft. The buckets are made of ¼-in. steel pressed from a single sheet and reinforced with a ¾x2-in. bar-strap fastened on the lip of the bucket, for taking the wear at this point. The speed of the elevator is 95 ft. per min. The head of the elevator is equipped with compound back gears of large dimensions and operated from the line shaft that drives the screen.

CHUTES—All chutes in the plant are lined with sheet steel.

ROLLS—The 60x30-in. heavy-duty roll (Fig. 3) is one of the largest smooth-faced rolls yet built in this country, considering the width of face and weight of machine. This roll has an overall dimension of 16 ft. The shafts are 16 in. in the hub and 14 in. in the bearings, each bearing having a length of 46 in. The frame is cast in one piece, and alone weighs 30 tons. The drive pulleys are made of cast steel, the main pulley being 96 in. diameter by 24 in. face, while the smaller pulley on the movable roll is 60 in. diameter by 14 in. face. This roll is operated at a speed of 50 r.p.m., or a peripheral speed of 785 ft. per min.

The rolls are equipped with an ingenious lateral adjusting device that prevents corrugating or channeling of the roll tires. The bearing of this roll is so constructed that it is double the size required for the work being done, is positively dust proof and efficiently lubricated. Its capacity is 300 cu.yd. per hr., crushing from 4 in. down to 2 in.

POWER—The large crusher is operated by a 300-hp., 3-bearing, form "M," mill-type induction motor, of the slip-ring type, and has about 2½ times full-torque load in starting. It operates at a speed of 560 r.p.m. This motor is equipped with a self-starting regulator, 33x27-in. pulley, and drives a jack shaft with a 26-in. triple leather, endless belt, the pulley on this shaft being 94x27 in. This jack shaft is equipped with an approved individual friction cut-off clutch which permits the starting of the crusher after the motor is in motion. On this jack shaft is a 60-in. heavy sheave wheel, with 15 grooves for 1½-in. rope, by which the large crusher is operated, the driving sheave on the crusher shaft being 11 ft. in diameter. A suitable tension carriage and idler sheave is installed in connection with this rope drive.

It will be noted that on account of the intermittent load, due to the irregularity in the size of product fed into a crusher of this size, it becomes necessary to have great flexibility in the transmission, although it is apparent that when this crusher is operating at full speed, with the enormous momentum of the two 12-ft. 15-ton flywheels revolving at a peripheral speed of 3400 ft. per min., there can be but little variation.

The motor for operating the 3x6-ft. crusher is 150 hp., 560 r.p.m., and of the same type as the 300 hp. motor above mentioned. It is equipped with self-starting regulator, and a pulley 29x21 in. is belted direct to the crusher, with a 20-in. extra double leather, endless belt.

The crushing roll is operated by a 100-hp., 560-r.p.m. motor, of the same type as the others, and is equipped with a pulley 21x17 in., which drives a 108x17-in. pulley on a jack shaft, this jack shaft operating the rolls and also the countershaft that drives the roll feeder.

The elevator and screen are driven by a separate 50-hp. type "K" squirrel-cage induction motor, equipped with self-starting regulator, and operates at a speed of 850 r.p.m.

There are two conveyors in the plant—one, the short or cross conveyor, is operated by an individual 5-hp. type "K" motor, direct-connected through gearing and countershaft; the other, or main conveyor, is driven by a 15-hp. type "K" motor, direct-connected through gearing and operating at a speed of 850 r.p.m., and provided with an automatic starter.

The entire plant will be electrically operated by power transmitted from New York City, with current of the A. C. form, 3-phase, 60-cycle, 440 volts, stepped down from 2200 volts.

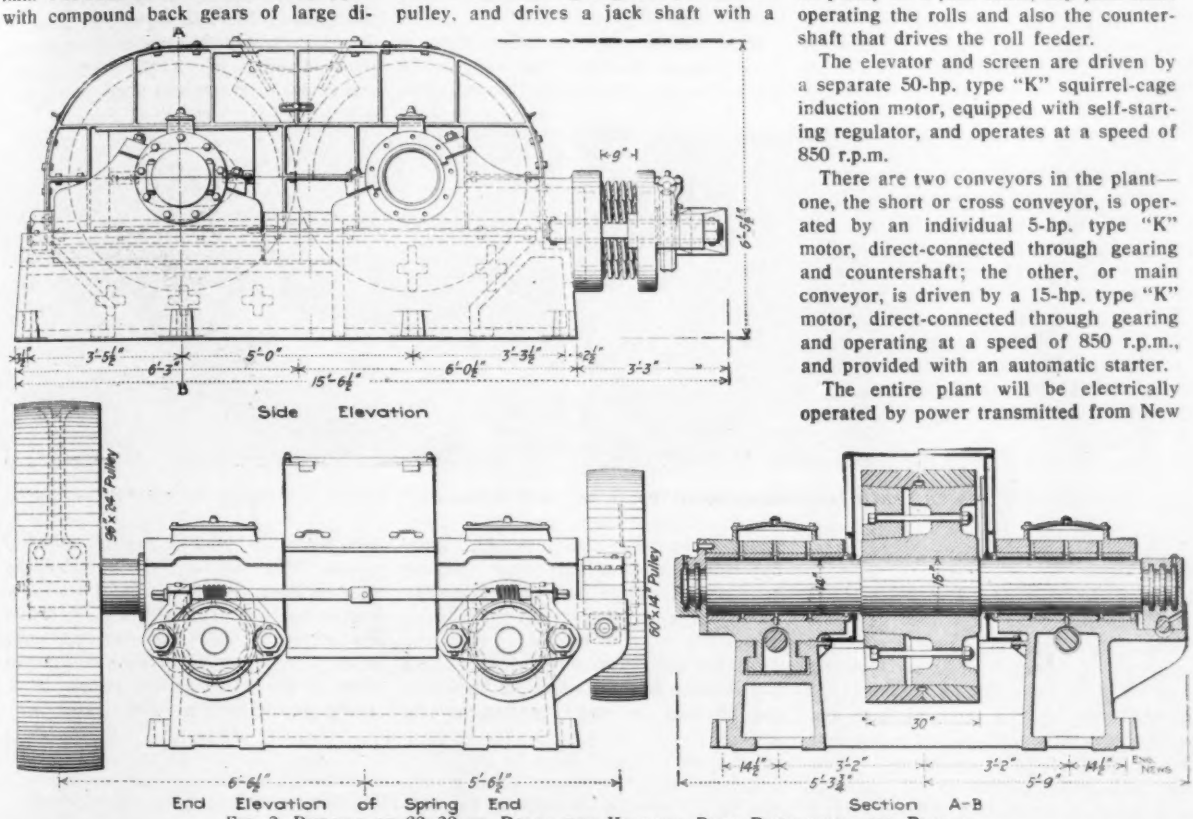


FIG. 3. DETAILS OF 60x30-IN. ROLLS FOR KENSICO DAM ROCK-CRUSHING PLANT

PERSONNEL

The work is being done under the supervision of the Board of Water Supply, City of New York, with J. Waldo Smith, chief engineer.

The contractor, as noted above, is H. S. Kerbaugh, Inc., of New York and Philadelphia, with Beverly R. Value as chief engineer, B. C. Collier, resident engineer, and G. H. Angell, superintendent.

The crushing plant was designed by the Taylor Engineering & Manufacturing Co., 30 Church St., New York, and is being installed in its entirety by them, including all buildings and the setting of the machinery.

FIELD AND OFFICE

An Efficient Cheap Dam

By H. D. MENDENHALL*

In the Florida Pebble Phosphate Mining district there exists a need of dams that can be constructed cheaply and rapidly; and although not having to last long, be efficient while they do last. These requirements seem simple and easy to fulfil, but the failure to fulfil them has been the cause of more worry and profanity and, incidentally, more delay and expense than any other one item in the general cost of mining phosphate rock.

From an operating standpoint dams are needed for the circulation of waste water for settling and re-using. But as the water discharged into the circulating system contains on an average 10% of solids in the form of mud and sand, and as not less than 4000 gal. of water thus laden are liberated every minute, it does not take many months to fill up most any pond or circulating system. As a rule an average circulation system lasts from six months to a year under ordinary conditions. So it can be readily seen that too much expense must not be incurred for dam construction.

The need for rapid construction comes from the fact that during all of the writer's experience in phosphate mining he has never seen the time when the exact location of a circulating water dam could be foretold by more than a month or two, and as a rule the call is not made until the immediate need has come, and so, to be of use at all, the dam must be constructed in an almost impossibly short time.

The need for strength is important because the breaking of one of these dams brings on a multitude of calamities. In the first place, it wastes not only the 4000 gal. per minute that are being put into the reservoir, but the contents as well. This means the necessity of raising clean water enough from the wells to run the hydraulic operations until circulation can be restored, and as artesian water comes only to within an average of 40 ft. of the surface of the ground, it is easily calculable how much money will be lost in pumping.

And what is really most important, in this district, the farmers and natives generally are very hostile to the phosphate companies and look for every opportunity to prosecute them. So the moment an undue amount of muddy water starts down a creek branch, innumerable lawsuits are begun. As the dams are usually some 6 or 8 ft. high and include an area of about 40 acres, the breaking of one liberates several hundred acre-feet of mud and water. The result is obvious and the cost of rock jumps immediately.

The material most readily available, and the one that all naturally turn to, is the natural earth of the region. This earth is composed of loam, fine sand, and a small percentage of clay, making in all a substance that is not only of low specific gravity, but one that easily "melts" when exposed to the action of the water. This "melting" is a combination of sliding down to the natural angle of repose, which for this material, wet, is approximately 2 in 100, and the actual going into solution or suspension of a certain percentage of the total. Fig. 1, shows the effect on an earth dam subjected directly to the action of water. The material is also more or less porous, or at least permeable, so that water ulti-

FIG. 1. EFFECT OF WATER ON EARTH DAMS BUILT OF NATIVE SOIL

FIG. 2. A CHEAP EARTH DAM WITH WATERPROOF FACING

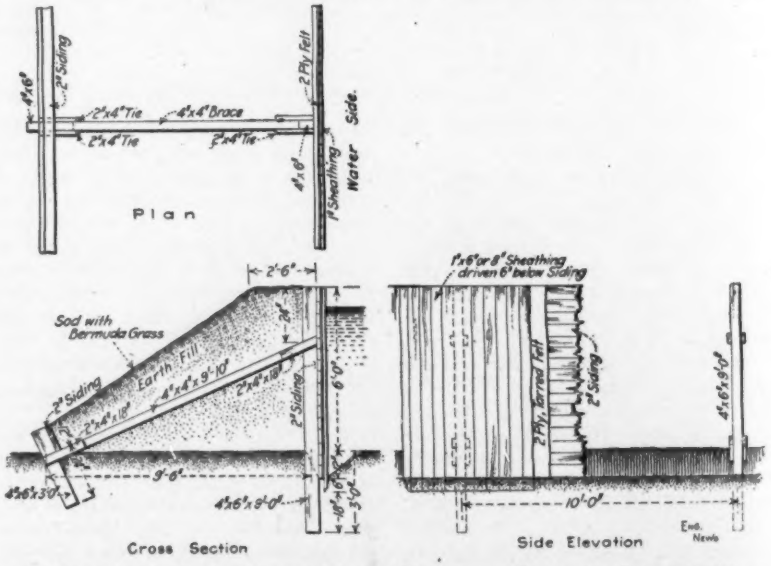


FIG. 3. RESERVOIR FOR PHOSPHATE-ROCK TREATMENT FORMED BY INEXPENSIVE EARTH DAMS

*Civil Engineer, Lakeland, Fla.

mately seeps through it, dissolving and washing away the toe of the dam.

The solution of the problem of building a substantial dam of this material would seem to be reached by putting some sort of a core wall through the middle. But on second thought it is obvious that the "melting" would still continue on the upper face. It would be out of the question to build a dam of the material on its angle of respose. Still, despite all of these manifest defects, operators have continually built these dams, usually on a slope of 1½ to 1, or 2 to 1, with all the accompanying ills, and many are still doing so.

The call came to the writer one day for a dam that was proof against breaking, because of hostile neighbors, and at the same time could be built 6 ft. high on a ledge about 15 ft. wide. He hit on the idea of building the core wall on the outside instead of the center of the dam.

The dam (see Fig. 2) as designed and erected is simply an impermeable facing built on a timber framework and filled with earth. The framework for the typical 6-ft. dam consists of 4x6-in. pine posts 9 ft. long, sunk 3 ft. into the ground and spaced 10 ft. apart. At a point 9 ft. 6 in. horizontally back from these posts are other posts 4x6-in.x3 ft. long, sunk 2 ft. into the ground, and inclined away from the front posts about 30° from the vertical.

From the intersection of the short post with the ground line to a point on the long post one-third the distance from the top to the ground, is put in a 4x4-in. strut, so connected to the two posts with 2x4-in. cleats as to withstand both tension and compression. On the front face of the long posts are spiked horizontally 2-in. rough pine planks; these planks extend to about 1 ft. below the general surface of the ground.

Completely covering the water side of this facing is tacked 2-ply tarred felt roofing, and on the outside of this is nailed a facing of 1-in. plank, applied vertically, and driven into the ground some 6 or 8 in. below the bottom run of 2-in. plank. After the facing is on, the trench for the bottom run of horizontal 2-in. plank is refilled with earth. The 2-in. planking acts as a combined retaining wall and backing for the waterproofing, the tarred felt serves to prevent the water washing through the dam, and the 1-in. facing serves as a mechanical protection to the felt.

The outside sheathing driven the given distance below the ground surface also serves as a check to the water washing under too rapidly. Since it is expected that a small amount of water will percolate through, anyway, as well as quite a quantity will wash down from the top during rains, a 12-in. retaining wall is laid along the inside face of the short rear posts, the bottom edge being flush with the ground. This prevents the toe from washing, and also serves to help the short posts resist the overturning pull that they are subjected to during the earth filling period and before the water has risen.

After the structural part is completed, the back is filled as shown with ordinary earth, and sodded with Bermuda grass. Adequate spillways are of course supplied to prevent overtopping the dam.

Fig. 3 shows one of these dams about 7 ft. high under a hydrostatic head of about 5½ ft. It has fulfilled its function perfectly, and is in splendid condition even after the heavy rains of the Florida rainy season. The toe has not washed at all.

The total bill of material for a 20-ft. section of this dam 6 ft. high is:

2 pieces rough pine	4x6	12 ft.	48 ft. B.M.
2 pieces rough pine	4x4	10 ft.	27 ft. B.M.
1 piece rough pine	2x4	12 ft.	8 ft. B.M.
	2x6 or 8	20 ft.	280 ft. B.M.
	1x6 or 8	15 ft.	150 ft. B.M.
Total lumber			513 ft. B.M.

1.4 squares 2-ply tarred felt.
5 lb. 20d wire nails.
2 lb. 8d wire nails.
27 cu.yd. earth fill.

From this it can readily be calculated what the cost will be for any given length and locality.

This type of dam, as described and erected, seems to be solving the problem as encountered in this country perfectly. The softness of the surface and regularity of contour of the land lend themselves to its success.

Concreting Plants for Building Retaining Walls*

By W. C. Armstrong†

Some interesting plants were designed and constructed by the various contractors for hoisting and conveying concrete and concrete materials [in building the retaining walls and bridge abutments for the elevated approaches of the new Chicago terminal of the C. & N. W. Ry.].

Cableway—For constructing the walls between Milwaukee Ave. and the P., C., C. & St. L. Ry. property a cableway was erected by Geo. W. Jackson, Inc. This was supported on anchored towers, one located in the triangle between Lake St. and Milwaukee Ave., and the other located in the driveway just south of the P., C., C. & St. L. Ry. freight house. The towers and their anchorages were supported on car wheels and tracks which permitted of their being shifted east and west to reach either the east or west wall or any part of the intervening abutments. The device worked well, but it was not economical, and its capacity was too limited. The best average rate obtained in eight hours was 24 cu.yd. per hour.

Derrick and Dump Car—For the work between the P., C., C. & St. L. Ry. property and Jefferson St., the concrete was mixed at the ground level and hoisted to the top of the wall in a drop-bottom bucket by a stiff leg derrick; there it was dumped into a hopper, from which (by opening a gate) it was poured into a dump car which was pushed by hand to the proper place on the wall. A track, of course, had to be built over the top of the forms to be filled. This device was more economical than the cableway, as the work of installing and moving was considerably less. An average rate of 33 cu.yd. per hour for eight hours was the best record.

Elevator and Dump Car—The plant erected by the Bates & Rogers Construction Co. consisted of an elevator tower, framed in wood, extending from the street level to a height of about 10 ft. above the top of the wall. In this an elevator bucket was operated by a hoisting engine at the street level. This bucket was arranged to dump automatically, when it reached the top, into a dump which was pushed by hand along and above the top of the wall. The concrete mixer was mounted a little above the street level so as to discharge into the elevator bucket when it was at the bottom of the tower. The material was fed into the concrete mixer from a hopper, placed a little higher than the mixer, through a gate operated by hand. The gravel was brought to the mixing plant in drop-bottom wagons.

In the first plant of this kind installed a stiff-leg derrick was erected which lifted the wagon box off the trucks and hoisted it up above the hopper into which the contents were dumped. In all subsequent plants erected where the material was delivered in wagons, an incline was built, up which the wagon was drawn by a cable after the team had been removed. The contents were dumped into the hopper and the wagon lowered to the street again by gravity. This method of elevating the material was found to be more satisfactory than the former.

The operation of this plant was successful in every respect. The best average rate in 10 hours was 37 cu.yd. per hour.

The concrete was transported by the dump cars in some cases as far as 500 ft. from the mixing plant. For depositing the concrete in foundations it was transported on the track above the top of the wall as far as the forms were built and the elevated track supported on the forms was constructed; at that point it was dumped into a chute which delivered it into another dump car running on a track at the ground level.

Elevated Mixers; Concrete Chutes—The method adopted by J. J. O'Heron

*Extract from a paper on "The New Passenger Terminal of the Chicago & Northwestern Ry.," presented before the Western Society of Engineers (Chicago), and published in the December number of the Society's "Journal." The terminal was described and illustrated in Engineering News, Aug. 17, 1911.

†Terminal Engineer, Chicago & Northwestern Ry., Chicago.

& Co. consisted in the use of portable concrete mixers, rigged with the ordinary power-hoist charging bucket. For pouring the foundations the mixers were placed at the street level. The gravel used on this work was delivered in side swing cars on the temporary track, previously referred to, which was elevated about 20 ft. above the street level. The gravel was dumped from the cars to the ground and carried to the charging buckets in wheelbarrows, in the usual way.

The mixers discharged into sheet-metal troughs or chutes which poured the concrete directly into the pit. In some cases the same machines were used on the super-walls by elevating them above the top of the walls so the chutes would deliver at the top of the forms. When the mixers were in this position the material was either dumped from the cars upon platforms or shoveled directly into the wheelbarrows.

WALL MACHINE—A considerable portion of the long straight wall along the south side of Austin Ave. was built with a specially designed wall machine, which consisted of a power mixer mounted on a heavy portable truck, with a power-hoist charging bucket, and in addition a power-hoist elevating bucket. The charging bucket was filled in the usual way. The mixer discharged into the elevating bucket, which was attached to a steel frame guide leading to the top of the wall, where the bucket dumped automatically. The elevating bucket was operated by a steel-wire cable attached to a drum on the engine which ran the mixer and which was mounted on the platform alongside of the mixer.

The machine did some effective work, but it was too unwieldy to be generally satisfactory. The principal objection to it was that it could not be moved along close to the wall without interfering with the form bracing. It did not require as large a crew to operate it as was required with some of the other plants, the reduction in force being due to the direct delivery of the mixed concrete into the forms, without the use of dump cars and the men necessary to operate them. The best result secured was a rate of 25 cu.yd. per hour.

In making these comparisons of the different plants and their efficiency it must be remembered that the conditions were different in each case: (1) the manner in which the material was delivered on cars, whether at the site of the plant or at some distance away, whether on the elevated temporary track or on some surface track; (2) the number of cubic yards that could be placed from one setting of the plant, involving the question of frequent installations of the plant or a longer haul of the mixed concrete; (3) the distribution of the volume of concrete, whether in a continuous heavy wall or in isolated abutments and piers. All these had to be taken into account in determining the kind of plant best suited to the conditions. It must therefore not be inferred that any unfavorable comparison is a reflection upon the judgment or ingenuity of the contractor; for each had different conditions to meet and each was designed to meet the conditions peculiar to that part of the work.

It might be stated as a general principle in the design of concreting plants that the capacity of the mixer should be made the determining factor in the output. The charging, hoisting and conveying appliances should be designed with such a degree of flexibility as to preclude the possibility of retarding the mixing process by delay in charging the mixer or delay in removing the discharged concrete. The most economical mixer, other things being equal, is the one which discharges its mixed batch and receives its new batch in the shortest time.

Economical Layout of a Concrete Plant

BY G. C. SCHERER*

Economy of layout is the factor which makes profit for the contractor, and makes it possible for the engineer to keep within his estimate or complete the work for less than the estimated cost. It is a consideration of prime importance.

A lock and dam are being constructed on the Coosa River, near Rome, Ga., by the United States Government, in the interests of navigation alone. A very compact arrangement for handling raw material, as well as for mixing and placing concrete, is employed here. This work is under the immediate local charge of D. M. Andrews, who has had many years' experience in such work, and the ideal arrangement is due to his varied experience.

The layout is so compact and symmetrical that a description of it may prove of value.

*Montgomery, Ala.

Fig. 1 shows a ground plan of the layout; Fig. 2 gives a view looking upstream.

Rome, some 8 mi. above the location of the site of this work, is the point from which cement and general supplies are received; sand and gravel are dredged from the river just outside the coffer-dam, screened and stored in bins.

Immediately at the edge of the upstream end of the coffer-dam there is erected a large guy derrick with one stiff leg, operated by a 50-hp. three-drum American Hoist & Derrick Co. engine with independent swinger. This derrick has proved itself capable of taking care of all unloading, storing and keeping the mixer steadily at work. Just in front and inside the coffer-dam the mixer is located, while immediately at the shore side of the coffer-dam are storage bins and screens for sand and gravel. Narrow-gage tracks run from the coal-storage bins and cement house to within reach of the derrick, permitting the derrick to be used to unload cement and coal directly within reach of their respective storage places. The derrick also unloads sand and gravel from barges and places it in the storage bins, and keeps the small bins of the mixing plant full.

The mixer plant is set low enough to the bottom of the lock pit for small cars to run under to receive the mixed concrete. Down the entire length of the lock pit two sets of parallel tracks are run. These tracks perform double duty. The rails forming each set are spaced far enough apart to permit small cars conveying concrete to be operated, and the two sets are spaced far enough apart to operate a traveler on double tracks. These tracks and the traveler are seen in the view, **Fig. 2.**

This traveler is a movable derrick, which is moved forward or backward to the point where it is desired to deposit concrete. The concrete runs out from the mixer on one of the sets of parallel

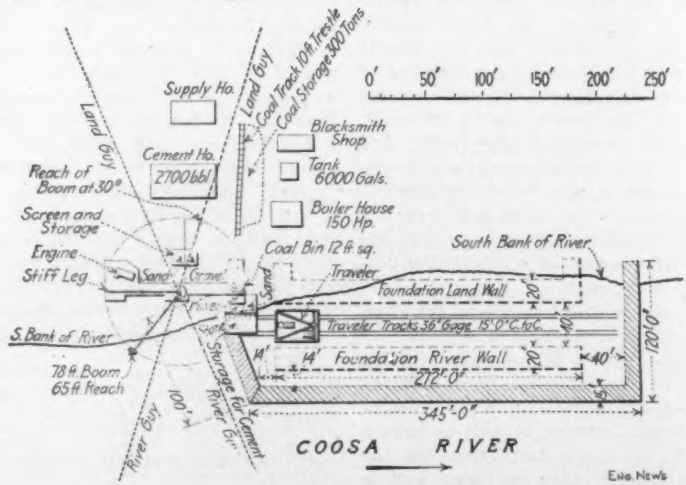


FIG. 1. PLAN OF WORKING PLANT, COOSA RIVER LOCK, NEAR ROME, GA.

FIG. 2. VIEW OF COOSA RIVER LOCK PLANT, LOOKING UPSTREAM

tracks, within reach of this derrick, which picks up the buckets and deposits the concrete in the walls at exactly the point desired. The traveler is provided with one boiler and two hoisters of two and three drums, respectively; the two-drum hoist, used to operate the concrete cars, has no boiler, but takes its steam from the boiler provided for the three-drum hoist.

The entire arrangement permits work to be done with a surprising minimum number of laborers, and thus materially reduces cost of operation. The close grouping of parts is well worth the study of any engineer or contractor contemplating a large volume of work.

The lock at which this plant is erected is 272 ft. long over all, 40 ft. wide in the clear, and 37 ft. high. It will contain 12,500 cu.yd. of concrete, and it is estimated that this will be placed at an approximate cost of $5½ per cu.yd., including forming.

Placing Bracing in a Coffer-dam Before Pumping Out the Water*

BY WM. ARTINGSTALL†

After the sinking of the steel tubes for the river section, two lines of Friestedt steel-sheet piling, with piles 65 ft. long, were driven so as to connect the crib (which was built across the steel tubes) with the single rows of sheeting extending out from the land sections, thus forming a double coffer-dam across the tunnel and parallel to the dock lines.

After the river portion of the coffer-dam was puddled, the question arose as to how to brace the single steel sheathing forming the sides of the dam. It would have been dangerous, if not disastrous, to attempt this in the usual way of framing the top tier of bracing on the surface of the water, then lowering the water a few feet and framing the second tier, and so on.

A diver carefully measured the distance between the sides of the dam for each 6 ft. in depth at each point where a brace was to be located. It was found that the dam was clear of obstructions to 30 ft. below the water surface. With the measurements as a base, a tier of bracing was framed which would fit at —30 [practically 30 ft. below water level, Ed.]. This was then sunk 4 ft., and the next set of bracing framed and sunk. The next tier was then framed complete and sunk, and so on until six tiers of bracing had been completed and submerged to place. The diver then securely wedged each set against the sheathing, and when the water was being pumped from the dam the necessary additional wedging and backing was performed. The bracing below —30 was placed in the usual manner by lowering the water to the required depth, framing the timbers, then pumping (and excavating if necessary) to the next depth, and so on.

This is the deepest coffer-dam built in this country, and the open-cut section is the largest and deepest open-cut section ever known. There is every prospect of the completion of the tunnel work early in 1912.

*From a paper on "The History and Reconstruction of the Chicago River Tunnels," in the "Journal" of the Western Society of Engineers (Chicago), November, 1911. The coffer-dam in question is at the end of the twin-tube steel-shell tunnel across the river at La Salle St., and was described and illustrated in Engineering News, Sept. 21, 1911.

†Division engineer, Board of Supervising Engineers, Borland Block, Chicago.

Making Practical Use of the U. S. Primary Triangulation System*

BY WILLIAM BOWIE†

When a survey is not contiguous to a previous survey, an initial position and azimuth must be assumed or determined astronomically. The position of this station is then used as the datum of the survey. Where two such independent surveys are extended until they join, the geographic positions of the points common to the two seldom agree. This discrepancy may be as much as one mile in a distance of 50 miles, as was the case in Porto Rico.

When a triangulation was made across the island the distance between Ponce and San Juan was found to be one mile shorter than the distance given by the Spanish chart. This was due to a relative station error or deflection of the vertical between the astronomic stations at the two places, on which the chart was based.

The Coast and Geodetic Survey started its charting of the coasts of the United States at many places, each separate survey depending upon an independent astronomic station. When each two of these surveys were joined troublesome discrepancies were usually found.

Eventually all the separate pieces of triangulation were joined on each coast, and a transcontinental primary triangulation ultimately connected the two systems. A mean position was then chosen and called the U. S. Standard Datum, and the position of each station of the connected triangulation systems was computed from it.

It is believed that this datum is final and that all surveys, maps and charts based on it will never need to be changed. It should be clearly borne in mind that it is the accuracy of the angle and base measurements and the strength of the figures, and not the lengths of the lines, which determine the grade of the triangulation. The primary triangulation of the United States has an average closing error of a triangle of about 1" and the lines vary in length from 4 to about 180 miles.

About 11,000 miles of primary and about 7500 miles of tertiary triangulation have been done in the United States by the Coast and Geodetic Survey and by the Lake Survey.

There is now a primary triangulation in all the states except five. It is planned to extend the primary triangulation into all parts of the country, and it is hoped that eventually no place will be more than 150 miles from a primary station.

*Read before Section D, American Association for the Advancement of Science, in Washington, D. C., Dec. 28, 1911.

†Inspector of Geodetic Work, U. S. Coast and Geodetic Survey.

The spaces not covered by primary can be controlled by secondary or even by tertiary triangulation. Since March, 1902, more than 3100 miles of primary triangulation have been added to the scheme by the Coast and Geodetic Survey. More than 1200 miles of this was done in a total observing period of 18 months.

It is needless to say that all the public surveys of the country should be connected with stations of the triangulation net of the United States, and for this purpose the triangulation will be extended into new areas as rapidly as possible. The organizations which are now basing their surveys on standard triangulation, wherever it is available, are the Coast and Geodetic Survey, the Geological Survey, the Corps of Engineers, U. S. A., the Forest Service, the Reclamation Service, the General Land Office and the United States and Canada Boundary Survey.

When the primary net has been much enlarged, all of the local schemes of triangulation of the several organizations should be adjusted to the U. S. Standard Datum, as will no doubt be done.

The United States and Canada boundary along the 49th parallel is controlled by tertiary triangulation which started from standard positions at its western end and it will be connected with primary triangulation at the 104th and 98th meridians. The United States and Mexico boundary monuments are connected with primary triangulation at a number of points between El Paso and Yuma. Whenever a resurvey of a state boundary is made the work should be controlled by triangulation supplemented, where necessary, by traverse; and all should be based on primary triangulation stations.

A notable example of the use of triangulation by a state is shown in the recent survey by the state of Maryland of the oyster beds of Chesapeake Bay and its tributaries. The boundary points of each natural oyster bed are referred to triangulation stations and their positions are given in latitudes and longitudes computed from the U. S. Standard Datum. These boundaries could be accurately reestablished, even if the monuments which mark all of the contiguous triangulation stations were destroyed.

The city of Greater New York has a primary triangulation system based upon the U. S. Standard Datum, which is used to control all of its cadastral surveys.*

An example of a private survey controlled by triangulation is that of the Clinchfield Coal Corporation, in Tennessee. A very accurate triangulation net referred to the U. S. Standard Datum was extended over the holdings of this company by its engineer. By numerous traverses from the triangulation stations latitudes and longitudes were determined for each turn of their boundary line, every shaft, whether in operation or only a prospect, each well, and in fact every point or object the exact location of which should be perpetuated.

Requests are increasingly made by Government bureaus, corporations and individuals for data of triangulation stations on which to base surveys and engineering operations.

*Engineering News, May 21, 1903.

Explanation of the Planimeter

By Charles A. Gilchrist*

The explanation of the planimeter usually given in treatises on surveying is so cumbersome that after scanning it the reader turns away with the feeling that, since the machine is already invented, perhaps after all an understanding of its theory is not essential.

The following explanation is offered, not with any assurance that it is new, but in the belief that it is at least in its very lowest terms. Attention is called to the fact that the proof is rigid and perfectly general. It applies to an instrument in which each extremity of the tracer arm moves in any locus whatever and hence includes both the rolling and polar planimeter.

Let h, Fig. 1, represent the tracer arm, and for the present consider the wheel as located at p, that is, with g and k (Fig. 2) each equal to zero. Let the line h move in such a way that its extremities are always upon any two given curves. Then will the line generate an area A, bounded by the two curves and by the first and last positions of the line.

The elementary area is the algebraic sum of a trapezoid and a triangle, and the expression for this area is $rh + \frac{1}{2}\Delta h^2$. The whole area is therefore $h\Sigma r + \frac{1}{2}h^2\Sigma\Delta$. But Σr is the total roll of the wheel, say R, and $\Sigma\Delta$ is the total angle Θ. Hence:

$$A = hR + \tfrac{1}{2}h^2\Theta \qquad (1)$$

If the wheel is located at p' (Fig. 2) then for positive values of Δ it suffers a negative roll of Δg, over and above the roll it would have had at p. Hence if R is the total roll at p', the roll corrected to position p is $(R + \Theta g)$ and equation (1) becomes

$$A = hR + (hg + \tfrac{1}{2}h^2)\Theta \qquad (2)$$

If the wheel is located at p'' its motion is precisely the same as its motion at p' since the only motion p'' may have that is not shared by p' is perpendicular to $p'p''$, and this produces no rolling.

If now the upper locus forms a closed figure and if the tracer point returns to its initial position by completing the closed circuit, then will the initial and final positions of the line be identical, the pivot point p having returned to its initial position by the way it went out. As the line returns and approaches its initial position, the area between the lines and the loci, that is, the area A as we have defined it, approaches the area of the closed figure. On closure Θ becomes zero and equation (2) reduces to

$$A = hR \qquad (3)$$

which is the equation for the planimeter in the case where the pole is outside the area to be measured.

It is apparent that the pole arm of a polar planimeter is simply a means of insuring that one end of the tracer arm shall move to and fro in the same path, that is, without inclosing an area, and the fact of that path being a circular arc is

*Manila, P. I.

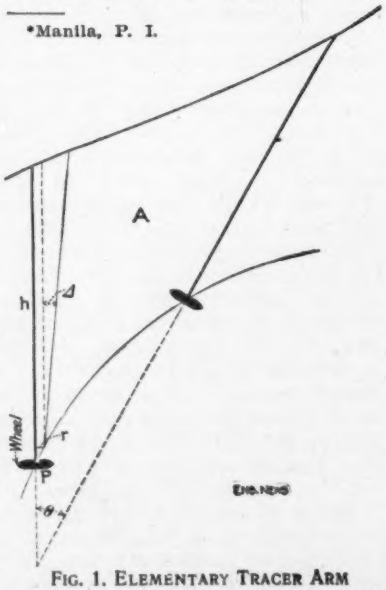


Fig. 1. Elementary Tracer Arm

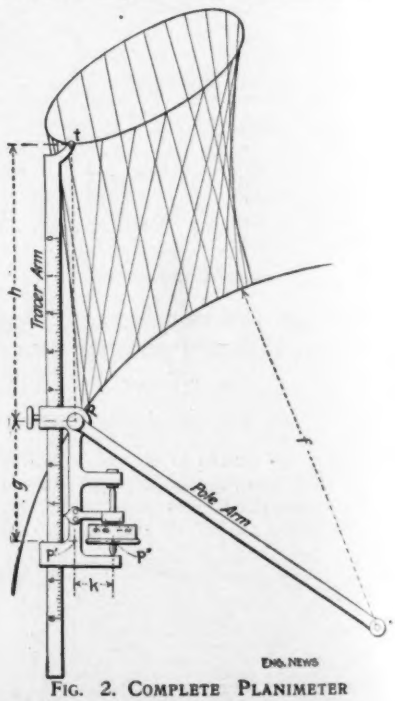


Fig. 2. Complete Planimeter

FIGS. 1 AND 2. DIAGRAMS ILLUSTRATING THE ACTION OF A POLAR PLANIMETER

quite immaterial. The end of the tracer arm might be constrained to move in a groove of any shape, or it might be attached to a pivot on an ordinary rolling parallel rule without any effect upon the result or necessary change in the calibration of the instrument.

In the case where the pole is inside the area to be measured, Θ is not zero, but 360° or 2π. For this case, equation (2) gives only the area between the pole circle of radius f and the given locus. Hence if we add to this the area of the pole circle, πf^2, we obtain the desired area. Putting 2π for Θ in (2) and adding πf^2, we obtain the equation

$$A' = hR + \pi(2gh + h^2 + f^2) \qquad (4)$$

A Four-Sided Leveling Rod

By S. P. Baird*

Some time ago I saw a party of engineers running a set of precise-levels using a selfreading rod. The party consisted of instrument man, recorder, two chainmen and a rodman. Great pains was taken in setting the instrument to secure firmness, and practically all the time was consumed in setting up and in moving from one set to the next. Since seeing the party at work I have thought of the subject a great deal and have designed, made and tried a new rod for use as a selfreading rod. As I think that it will interest the field engineers I will describe it.

The peculiarity of the rod is not in the graduation, as any style marking can be used, but in the fact that it is graduated on each of its four faces, with the zeros of the faces not coincident.

For identification purposes I have called the different faces A, B, C and D. The zero of the A or principal face is the bottom of the rod; the zero of the B face I placed 0.432 above the bottom of the rod, and the zeros of the C and D faces I placed two and three times 0.432 above the bottom. For the information of the instrument man I marked the different faces at frequent intervals with the designating letter.

The use of the rod is somewhat as follows: The instrument is set up and the rod is held on the B. M., with the A face presented to instrument. This side is read and recorded, then on signal to the rodman the B face is presented, read, and recorded, and then the same is done with the other two faces.

The readings of the B, C, and D faces should be, respectively, 0.432, 0.864 and 1.096 less than the reading of the A or principal face. Unless the readings all agree after making the proper corrections for height of zero there has been some mistake in rod reading.

The object of the arrangement is to insure accuracy of rod reading. If an error is made in reading one face it will not likely be made in reading the succeeding faces, as the cross-wire will cut the rod at points that will give entirely different sets of figures.

I have tried this rod, keeping an accurate check on the time required for the different parts of the work, and find that the time required to read the extra three faces and make the necessary subtractions for check is less than 20% of the time required to set up, read one face, and move to the next set. In other words, for 20% more working time I have three checks on the rod reading.

In reading of the precise-leveling done recently in this state I notice that it is usual to use two rodmen, each man turning on different turning points. The object of this is to secure different rod readings with the same instrument height. The method does not compare to the plan suggested above in economy or accuracy.

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Interpolating Device for Uniform or Variable Subdivisions

By H. W. Nieman*

The device here described will be found of use in the construction of charts and scales of various kinds, and in graphic work generally. Although it may not be new, it is at least little known and the writer has never seen any account of it printed.

The device consists of a piece of tracing cloth with a number of radiating lines ruled on it. The base line CA, Fig. 1, is of any convenient length, and ten or more equal divisions of convenient size are laid off on the vertical AB and connected by lines to point C.

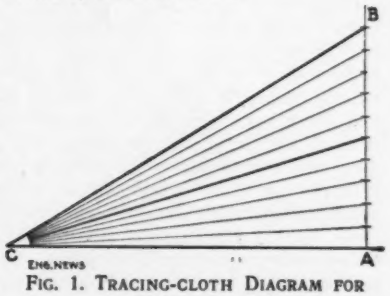

Fig. 1. Tracing-cloth Diagram for Interpolating

The following are examples of its use:

1. Suppose on the line ED, Fig. 2, a number of points have been plotted according to some law (in this case the points 2, 3, 4, 5, were laid off proportional to the logarithms of the numbers); it is desired, without calculating and plotting more points, to subdivide these spaces as accurately as possible. This cannot be done with dividers, as the subspaces vary in length. Lay the tracing cloth so that the first, fifth, and tenth lines on it pass through three of the

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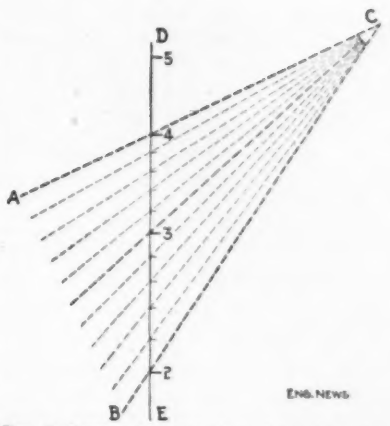


Fig. 2. Interpolating on a Logarithmic Scale with the Diagram

points plotted (in this case 2, 3 and 4). The intersection of the intermediate lines can now be pricked through with a pin, and these will subdivide the spaces into fifths very accurately, i.e., almost exactly as they would be if every point were plotted by logarithms. The base line CA on the tracing cloth must always be placed toward the more closely spaced divisions in order to get an accurate result. In case the three points are evenly spaced it will be found that CA will be at right angles to the line to be divided, and, of course, will divide the line up evenly exactly as a pair of dividers would.

2. Another case is shown by Fig. 3. Suppose for some reason it is not convenient to calculate the positions of the integral points as 2, 3, 4, etc., but the positions of other points, such as 5.24, 5.81, 6.63, happen to be known (e.g., from an experiment), as plotted on line AB, Fig. 3. Interpolation to find intermediate divisions and to plot a consistent scale may be done as shown at the left in Fig. 3. The base line of the tracing-cloth diagram is assumed to have the value 5.00, while the line 20 has the value 7.00.

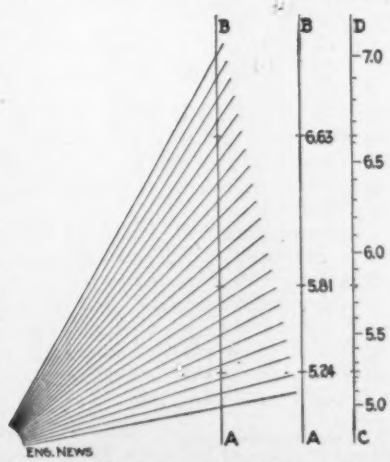


Fig. 3. Locating Integral Values from Known Fractional Points

The cloth is now moved around on the drawing until each of the three points has its designated value in relation to the radiating lines. The intermediate points may now be pricked through, giving us a scale as shown at *CD*.

Other uses for this interpolating device will naturally suggest themselves to the draftsman.

How Breakwaters are Kept in Alignment during Construction*

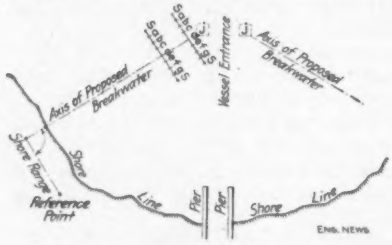
By Henry F. Alexander†

When the location of a breakwater has been decided upon, the center line or axis is first determined, and a range is established on shore making an angle with the axis as shown in the accompanying illustration. Stakes *SS* are driven each side of the axis, at right angles to it, and at a distance apart greater than the bottom width of the breakwater.

A wire is stretched between the two stakes, to which are fastened wooden paddles *a, b, c, d, e, f* and *g*. The paddle *d* marks the axis of the breakwater and its position is frequently checked by an instrument on shore. The outer paddles mark the outer edges of the breakwater, and the other two pairs are for convenience in making soundings on the fill.

Another set of stakes, wire and paddles is placed a few hundred feet ahead of the first set. When ready to begin placing stone the paddles are brought into line and the work begins.

The cross-wire between the stakes should preferably be made of several strands. The wooden paddles, which are



Plan of Layout for Breakwater Construction

made of thin pieces of board, 4 or 5 in. wide and about 2 ft. long, are fastened to the cross-wire by short pieces of wire interlaced in the strands of the large wire to prevent slipping.

The shore range is established from some convenient point overlooking the breakwater. When this range is laid off some prominent object such as a church spire can be used as reference point. After some of the work is above water a point marking the axis is established on this part of the work, and the axis between it and the shore is easily determined by setting up the instrument on the breakwater and sighting at the intersection on shore of the range line and the axis of the breakwater.

*From a paper entitled "The Building of Breakwaters at Lake Erie Ports," November "Journal of the American Society of Engineering Contractors," p. 394.

†Curllsville, Penn.

A Comparison of Four Methods of Making Soundings

By Myron H. Peck†

The work of dredging the Key Route basin of the harbor of Oakland, Calif., involves the building of an earth levee by clam-shell dredges, connecting the Southern Pacific Ry. mole and the Key Route pier, on a contract between the City of Oakland and the California Reclamation Co. The dredging of a channel parallel to the levee and an entrance channel along the Southern Pacific Ry. mole to deep water in San Francisco Bay will be under a separate contract by the Standard American Dredging Co.

This levee is about a mile long and half a mile from the present shore line. The earth is taken from the harbor side, leaving a channel about 220 ft. wide, and the embankment is to be paid for by place measurement of excavation. The weight of the embankment has caused continual rising of the bottom of the excavated channel, so soundings had to be taken directly ahead and behind the dredges on sections 50 ft. apart. Owing to varying conditions and requirements, four different methods have been used in making soundings before and during the progress of the work.

The hydrographic survey work involved three sets of conditions and requirements, namely: (1) Original cross-sections, 800 ft. long, every 50 ft. of a channel about one mile long and half a mile from shore, on a bottom known to be an alluvial deposit with very easy slopes; (2) original cross-sections, 800 ft. long, spaced 50 and 100 ft. apart on a channel about 6000 ft. long, 2000 ft. of which is along a solid mole and 4000 ft. along, but not parallel, to a pile pier; (3) cross-sections, from which to calculate the excavation for the levee, 300 ft. long, spaced 50 ft. apart, taken directly ahead of and behind the dredges.

In Oakland Harbor there is a mean range of tide of about 5 ft., with strong tidal currents. With the exception of two or three days a month the water was always smooth in the morning and always too rough for sounding in the afternoon. The original depth of water varied from 4½ to 7 ft. below mean low water, except in a part of the entrance channel, which was deeper. The finished depth under the dredging contract is to be 25 ft. below mean low water.

The soundings on the original bottom did not have to be located very closely, as a contour map of the area prepared by the ctiy engineer of Oakland showed easy and regular slopes. It was, therefore, decided to make soundings every 50 ft. on ranges 50 ft. apart. The irregular bottom left by the clam-shell dredges made necessary more closely located soundings, so these were made at 15-ft. intervals on the original ranges.

Rapid field methods were necessary, as only half of each working day could be counted on when the water would be smooth enough for making soundings. For most of the work any method involving the use of an instrument on shore was not advisable, for most of the ranges were too far from the mole, and the pier was narrow and subject to vibration from the passing every few minutes of electric trains. It was also desirable to have the man in charge of field work in the sounding boat, and save the cost of an instrument man.

Method I—For the survey of the original bottom, lines were run on the mole and pier and points established on parallel ranges on the cross channel between. These ranges were spaced 200 and 250 ft. from the crest of the rock wall forming the front of the levee, which is 22 ft. inside the "limit of fill." Flags fastened to 2x3-in.x18-ft. staffs were erected on these parallel ranges so as to allow lining in at any point.

The method of ranging in the soundings was rather unique. A skeleton float about 52 ft. square over all was built of 1x12-in. boards and braced to keep exactly square. At each corner an opening about 4 in. square was left; these openings were centered on the vertices of a square 50 ft. on a side. The float was towed to the far end of the channel, and a 2x3-in.x 18-ft. spud set in one of the corner holes in line with one of the parallel ranges and on the end cross-section line. The float was then swung, pivoting on the fixed spud, until another spud could be set on one of the parallel ranges. The other two spuds were then set, checking their position with the range lines, and the apparatus was ready for beginning the work of sounding.

A 600-ft. line was attached to one of the spuds, and soundings were taken both ways across the channel, using the two spuds on the section line as range flags. A second boat, containing only one man, stood by the float to shift the measuring line, so that soundings could be made out on one cross-section and back on the next. When both ranges were sounded three spuds were raised enough to clear the bottom and the float swung on the remaining forward spud through an angle of 180°. Another spud was then set on one of the parallel ranges and the first spud raised, and the float swung through 180° about the second spud. All spuds were then set as before with the float in its new position, 100 ft. farther along on the parallel ranges, and sounding proceeded as before.

*6426 Duncan St., Oakland, Calif.

The party consisted of two oarsmen (one in each boat), a recorder, in charge of party, a leadsman, a man to handle the measuring line, and a tide-gage observer on shore. With this party, 72 cross-sections, each 800 ft. long, were sounded in six working days, the average rate including all delays being 3 ranges of 17 soundings each per hour. The average rate of actual sounding work, excluding the time going to and coming from work, was 3½ ranges per hour. With smooth water and an experienced crew it was possible to swing the float into a new position in 2 min., but the average time was 13½ min.

The error in measurement along the channel by this method varied from 0.2 to 1.01%. Soundings were made with a sounding pole, and, therefore, were not seriously affected by the tidal currents. The stretching of the measuring line required its re-marking nearly every day. The location of the cross-sections could be checked by a row of piles parallel to the channel.

METHOD II—The float could not be swung on one of the spuds when the wind or current was strong. A supplementary method was devised using a right-angled wire triangle with two 50-ft. sides in place of the wooden float. Two flags set on one of the parallel ranges and one on the other range formed the three vertices of the triangle in place. Sounding operations proceeded as in the float method, using the same party; but progress was slower, as shown in Table I.

Using this method, an error of 25 ft. in 720 ft. along the channel was made. This is an error of 1 in 30, which was of no importance in this particular case, the slope parallel to the channel varying from 1 in 800 to 1 in 1000.

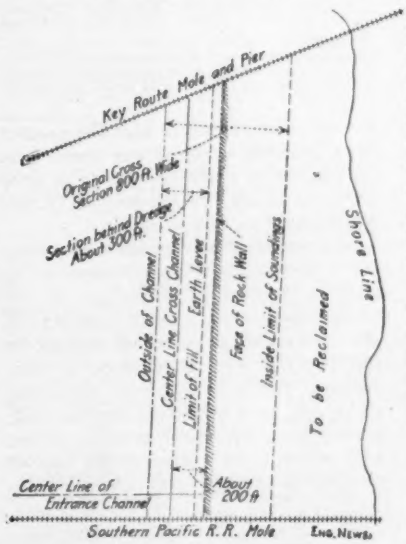
METHOD III—It was not easy to establish ranges parallel to the channel along the railway wharf and mole, but it was a simple matter to establish perpendicular ranges, so the common method of locating the soundings by ranges and an angle from a transit on shore was used. Instrument stations were established about every 1000 ft. on a line parallel to the channel.

The sounding boat carried one red and one white flag, and the transitman had one flag. The limiting angles for each range were calculated by the instrumentman, who signaled the boat when it reached the beginning and end of the section to be sounded on each range. The recorder in the boat raised the red flag for each fifth sounding, and the white flag for each other, recording the color of the flag and the number of each sounding, and the time of as many as possible. The transitman recorded the angle, time, color of flag, and number for each sounding.

The party consisted of a leadsman, recorder, oarsman, and a transitman and tide-gage observer on shore. At some stations the tide gage was so established that the instrumentman could also be tide-gage observer.

With the exception of one day at the beginning of the work, all ranges were set by the sounding party at times when the water was too rough for sounding. In all, 81 ranges, 100 ft. apart, each 800 ft. long, were sounded in 8 days of about 4 hours each. The average rate, including all delays, was 2½ ranges per hour; excluding the time required to get to and from work, the rate was about 3 ranges per hour.

METHOD IV—For soundings taken after dredging commenced, two ranges were established parallel to the cross channel, 300 and 400 ft., respectively, from the crest of the rock wall, on the land side of the levee. Flags were set at 500-ft. stations on these ranges from transit setups on the mole. On the sea side of the levee a third parallel range was established 300 ft. from the rock wall, and marked with flags at the 500-ft. stations. Soundings were made on cross ranges between this outside range and the rock wall by measuring in with a nickel-plated steel tape.



SKETCH PLAN OF CHANNELS AND LEVEE

This tape was wound on a horizontal drum in the stern of the sounding boat, the zero end of the tape being fastened to the drum. The first section to be sounded was located by measuring from the nearest flag on the outer parallel range. A temporary flag was erected to mark the end of this section, the tape was attached to the flag, and soundings were made every 15 ft. in to the rock wall. The tape graduations corrected by the distance from reel to leadsman gave the distance of the soundings from the rock wall.

After sounding to the rock wall the boat was backed to the starting point, to make the reeling-in of the tape easier. The tape was then fastened to a flag erected on the next section and the operation repeated. If thought necessary, soundings were also taken on the sea side of the range, which gave a maximum width of section of 600 feet.

The party consisted of an oarsman, recorder, leadsman, tapeman and a tide-gager observer on shore. On continuous sections, an average of 21.5 ranges, 300 ft. long, were sounded per day of 5½ hours, a maximum rate of 6 ranges per hour.

The location of the cross ranges, checked at each 500-ft. station, showed a probable maximum error of 5 ft. The accurate location of these 500-ft. stations was the most difficult problem. As soon as the rock wall was high enough their positions were checked by a line run along the top, and errors varying from 1 to 5 ft. corrected. With a strong current the bowing of the tape caused errors which were roughly allowed for by the recorder. In hard bottom the pull on the tape sometimes leaned the stick so as to cause an error, but this slant occurring only as the boat neared the rock wall, just about balanced the error due to the bowing of the tape. From 3 to 12 sets of soundings have been taken on over 90 sections, and in very few cases has there been an inconsistency in channel width amounting to 2 feet.

COMPARISON OF METHODS—Local conditions usually determine the method to be used in locating soundings, but a comparison of the effectiveness and cost of the four methods used on this work may have some general interest, and perhaps value.

Different methods of locating soundings may be compared on four grounds: (1) Acccuracy; (2) speed; (3) cost in field work; (4) cost in office work. As the four methods described were used on account of the varying conditions of the work, and not for the purpose of comparing them, it is difficult to deduce any relation between them on any of the four counts. The principal difficulty in deciding on a unit of measurement for work done is caused by the great variations in the spacing of soundings. As the number of linear feet sounded and the number of soundings per day will, other things being equal, vary inversely within limits, the products of these quantities should give a fair unit of measurement of work done for comparison.

As used, there is no doubt that Method IV (locating soundings by tape measurement) gave the most accurate results, and Method II the most inaccurate. Under favorable conditions, transit intersections on a range line (Method III) doubtless gives as good results as Method IV, but the error resulting from being off range is greater in Method III. It will be observed that Method IV could not have been applied where the others were used, without using a longer tape,

TABLE 1

Method	I	II	III	IV
Number of days covered by observations	3	2	3	10
Time sounding 1 range (min.)	9.7	9.1	9.2	4.1
Length of range in ft	800	800	800	300
Speed of rowing (ft. per min.)	82.5	88	87	73
Number of soundings per min.	1.75	1.87	4.2	4.9
Average spacing of soundings in ft.	50	50	27.8	15
Time Lost Between Ranges				
Shifting float or poles (min.)	13.5	22.5	.....	.....
Shifting measuring line (min.)	2.5	4.6		
Average total time lost (min.)	7.6	13.6	8.8	5.6
Average total time sounding 1 range (min.)	17.3	22.7	18.0	9.7

TABLE II

*Days' labor per crew-day	8	8	9	7
Length of range in ft.	800	800	800	300
Average number soundings per range	17	17	36	20
Average spacing of soundings in ft.	50	50	22.2	15
Number of Ranges Sounded				
Per crew-day	12	11.5	10.1	22
Per day's labor	1.5	1.4	1.12	3.1
Linear Ft. Sounded				
Per crew-day	9,600	9,200	8,080	6,600
Per day's labor	1,200	1,120	898	943
Average Number of Soundings				
Per crew-minute (Table I)	1.75	1.87	4.2	4.9
Per crew-day	204	196	363	440
Per day's labor	25.5	23.8	40.3	63
Number of Linear Ft. by Number of Soundings				
Per crew-day	1,960,000	1,800,000	2,933,040	2,904,000
Per day's labor	30,600	26,650	36,189	59,409

*In estimating the number of days' labor per crew-day it is assumed that the instrumentman and recorder in the boat are paid three times as much as the other men. With the exception of the "average number of soundings per crew-minute"; all figures include all delays except the running of preliminary lines. The time actually employed in sounding varied from 4 to 5½ hours per day.

and a longer tape might have put more pull on the end stake than it could bear, or one oarsman could apply.

An analysis of the distribution of time used in the different methods, in Table I, shows that the drag of the measuring tape decreases the speed of the sounding boat materially. It must be observed, however, that as the greatest speed observed while using this method of sounding was 80 ft. per min., this figure may be considered the maximum speed at which soundings can be taken every 15 ft., whatever the method used.

Aside from this marked difference, variations in the speed of rowing were probably due to differences in tidal currents, wind, and the efficiency of the oarsman. A comparison of the amounts of time lost between ranges (Table I) shows conclusively that for short ranges Method IV is the most rapid, except under ideal conditions for Method III.

Table II shows that Method IV cost less in field work than any other, with Method III ranking second. Assuming that it is possible to sound out on one range and in on the next when Method III is used, and allowing 0.8 min. for moving from one range to the next, the time required per 800-ft. range would be reduced from 18 to 10 min. (see Table I). A recorder would be required at the transit, increasing the number of days' labor per crew-day from 9 to 10. The product of the number of linear feet sounded by the number of soundings per day's labor would be 58,626, leaving Method IV still the cheapest in field work.

No costs of office work have been kept, but it is obvious that field notes which give the location of soundings in the cross-section directly will require less office work than those which require the multiplication of a distance by a trigonometric function. With a slide rule, about 200 such reductions can be made per hour or, say, 1200 per day, which adds about 1 day's labor to the cost of each 400 soundings (assuming the computer's time worth three times day labor). For comparative purposes, this adds about 10% to the cost of sounding by Method III. Plotting cross-sections is also somewhat easier when the soundings occur at regular intervals.

TABLE III.

	Method	Number of Days Covered by Data	Length of Range, Ft.	Ranges per Hr. Actual	Ranges per Hr. By Formula
I.	Float and measuring line	3	800	3	3
II.	Flags set by measuring wires	2	800	3	3
III.	Transit and ranges	8	800	3.2	3.0
IV.	Tape and ranges	2	300	4	4.2
	Tape and ranges*	51	300	3.2	4.2

*The work done in the last 51 days was on scattered ranges, when there usually was little incentive to speed. The two days on the fourth method were continuous sounding.

The figures in Tables I and II are reliable only for purposes of comparison, and should be used with great care in estimating the time required for, or the cost of, proposed work. The following outline for an estimate is suggested:

(1) Running of preliminary lines and levels, setting tide gages, etc.

(2) Personnel and daily cost of sounding party.

(3) Number and length of ranges to be sounded.

(4) Number of hours per day when sounding will be possible, excluding time for getting to and from work.

(5) Assuming speed of boat and time lost between ranges, calculate average number of ranges that may be sounded per hour (see items in (3).

(6) From items (2), (3), (4) and (5) calculate time required, or cost, as needed.

The following empirical formula may be used in calculating item (5):

Number of ranges per hour equals

$$\frac{60\ min.}{L + V + T}$$

where

L = Length of range;

V = Speed per min.;

T = Time lost between ranges in min.

$$\frac{60 \times 70}{L + 10 \times 70} = \frac{4200}{L + 700}$$

when V is taken as 70 ft. per min. and $T = 10$ min.

Table III shows how the results of this formula check with the work actually done.

Engineering in the Tropics; West African Experiences

The account of an engineer's experiences in British West Africa, printed in our issue of Dec. 7, 1911, as "Notes from a Railway Engineer's Experience in West Africa," by Hilder Daw, brings an interesting supplement from E. Blockley. The new account confirms the former one, but modifies it and makes some important additions.

It makes evident that the engineer requires common sense, fairness, resource and sanitation. The first three are needed everywhere; in the tropics, sanitation is the big added requisite. This has been emphasized before, but today we realize much more clearly than in the past that sanitation means not mere personal cleanliness, but regulation and care of the community.

Mr. Blockley's letter follows:

Mr. Daw refers to the excellent sanitary arrangements as conducted at Panama. The Liverpool, England, School of Tropical Medicine has for years been trying to educate the "White Man" who resides in the tropics along sanitary and health-preserving lines. For some reason the average "White Man," after a short sojourn in West Africa, becomes absolutely careless regarding sanitary precautions. I have visited engineers', traders' and mining companies camps where the white men's quarters were in as unsanitary condition as were Cripple Creek and Goldfield in their early boom days. If these camps were "pestilential," you can judge what occurs in the tropics, when empty tin cans, garbage, etc., are not properly disposed of or latrines built. Another trouble is to make the white man keep his head and back of the neck covered for protection against the sun's rays, and to kill the mosquito which may have gotten under

his mosquito net before retiring for the night.

The unhealthy and unsanitary conditions under which white men are compelled to work on the Gold Coast are principally due to the fault of the engineers in not demanding that their boards of directors provide sufficient funds to put their camps in a proper sanitary condition. The engineers are also at fault in not inspecting both white and native camps each day to see that they are kept in a sanitary state and that the domestic water supplies are not contaminated. The government should instruct the native along these lines.

The British colonial officials I found living on the Coast were very lax in not making the natives clean up their villages. When a white man died his case was usually diagnosed, if attended by a physician, as malignant malaria or black-water fever, very seldom typhoid (which is quite prevalent) or yellow fever, because if the latter a quarantine would be established. When a case of yellow fever does occur it is usually hushed up, like the 21 deaths which occurred at Mantraim in 1902.

Mr. Daw mentions the number of deaths attributed to fever, but thinks many are caused by poison administered by the native. This is very true to a great extent; the West African Negro is vindictive, like every other person, civilized or uncivilized. After two years' sojourn on the Gold Coast I found the various tribes invariably susceptible to discipline and work, if their employer treated them justly and saw that they received their correct pay and chop allowance, the principal thing always being to keep your word with them. The natives are like schoolboys, who usually have a great sense of justice. Should a native be caught stealing or breaking rules, and receives a severe flogging, he bears no ill will to his "massa"; but if flogged, punished or abused unjustly, woe unto the man who does so: he will surely get a little "sass wood" in his soup, or ground glass in his "chop." Then the man's death is attributed to fever.

There is no doubt that it is impossible for a white man to live in the West African Jungles and retain his health. I have travelled for days through the dense jungles where the fungus falls from the tree to the ground and decays; the odor of it is most nauseating, and the consequence is you have no appetite for your usually very inferior quality of canned foods—thence fever.

Regarding food supply: There is no reason why companies operating in West Africa cannot install small ice machines and obtain regular supplies of refrigerated meats and fresh vegetables for their white employees, at the commencement of their operations, in place of purchasing a large quantity of heavy and expensive mining machinery before determining if the machinery is suitable for their requirements.

West Africa is known as the "white man's grave." It certainly is a graveyard for mining machinery, which is to be found scattered and abandoned on the coast, where it was discharged from the steamer, or upon the river banks, where it had been left after finding it was too heavy and expensive to transport through the jungles, where there were no roads to the mine, which mine was only approachable by a narrow path over which people can pass in single file.

If proper foods and living quarters were provided for the white employees and opportunities given them to visit neighboring settlements (where too much drinking is not indulged in), say every three or four months if they so elected, instead of keeping the men practically in a state of peonage until their agreement for one year or longer expires; if this were done the men would better retain their health, and employers would get a greater amount of efficiency. Another drawback which is attributed to climate is that during part of the year it is almost an impossibility to get your clothes dry. This is the fault of man as well as the climate, for I saw but one stove during the time I was in West Africa, and that one was owned by an American.

Let me say that no man, be he engineer, contractor or trader, has any business in the tropics in charge of men without some knowledge of medicine and surgery, even though it is customary to have a qualified practitioner with the party if the undertaking is of any magnitude. Not only the white employees require medical attention but the natives also. I always made it a rule to line up the native employees at 6 a.m. for morning roll call, in companies under their respective headmen, and at the same time for medical inspection. The natives who were sick or not in physical condition for work received treatment and were laid off without pay, but were given their chop allowance. If ever it was found they were playing "old soldier" this allowance ceased, which invariably caused them to report for work immediately.

In the episode of the foreman dragged from camp and murdered, Mr. Daw does not say if he was a white man or a native. It is customary among certain native tribes that, should a native murder another, they peg the murderer to the ground and let the driver ants do the rest. If the foreman were a white man, in the employ of the Colonial Government, something must have been radically wrong, for the natives well know that his death would be quickly and surely avenged.

Speaking of the new port, I presume Mr. Daw means Secondi Bay, but he gives a rather erroneous idea of the distance which the Secondi & Kummassi Ry. is built, for in 1902 the railway was in operation between these two points, if I remember rightly, Tarkwa being only about 60 miles inland from Secondi and less than one-third of the distance to Kummassi.

Speaking of trees falling, this occurs in all forests and is always a source of danger, even in Oregon, as an engineer connected with a well known firm of eastern consulting engineers can vouch for after sitting out in the middle of a swamp in the Cascade Mountains nearly all night when on his first visit "out West." It is quite a common occurrence for the natives to get injured in the jungles, for very few know anything about woodscraft. If given an axe and crosscut saw to fell a tree, as soon as the white foreman has turned his back they will throw them down, take up their machets and go to work like beavers, cutting around the tree, irrespective of size, paying no attention to which way the tree will fall; the consequence is the natives are continually getting hurt. I know of one instance where a government official had two men killed and five injured, nothing being said about it at the time. Had such a thing occurred in a civilian engineer's camp there would have been no end to the trouble which the officials would have caused that poor engineer, especially if the local commissioner were tainted with the "tar brush." If the government engineers, with 2000 natives at their disposal, are in such a hurry and do not take time to see that the native was taken out from under a fallen tree and buried or his corpse turned over to his own people, it is not surprising the native has little use for the white man in West Africa.

What can be expected from men when in the Service in that country, who are too lofty and superior to condescend to associate with the civilian engineers? I recall with amusement when, conducting a government engineer over the work, he saw the combustion-chamber door of a return-tubular boiler, and remarked, "I consider that a very crude door for use as a fire-door." When told the door was only opened on an average once a week to clean out soot, etc., he replied, "Well, my dear man, where do you put in the fuel?" When shown, he could not understand how the smoke got into the "chimney." The native fireman, I expect, is still laughing at that "white man." And he would have lost caste if he had taken "chop" with me!

I did not know that the time of daylight and darkness had changed in that country. When I was on the Ancobra River it was daylight at 6 a.m. and dark a few minutes after 6 p.m. This would vary about 10 min. at midsummer and Christmas on account of being 4° north. I am thinking Mr. Daw's "boy" must have broken his thermometer, for the mercury seldom goes above 102° F., usually ranging between 78° and 96°. The heat is simply intense, and a person is constantly perspiring on account of the humidity.

The country is rich in minerals, but before it can be developed the Colonial government and the development companies will do well to use modern machinery on their construction work, and not depend upon native hand labor for everything, as it is most expensive. The usual excuse is that machinery requires white skilled labor to operate and this labor is difficult to obtain on account of the existing unhealthy conditions. When those conditions are changed by enforcing rigid sanitary rules upon the works, making the camps comfortable, and supplying the white employees with proper, wholesome food, cooked in a cleanly manner in a kitchen, and not allowing the native cooks to handle the food upon the dirty floor in the galley, a white man may be able to exist in that country.

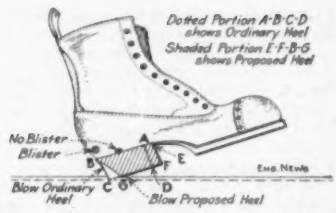
E. BLOCKLEY,
Late Constructing Engineer and Manager, Ankobra (Taquah & Abosso) Development Syndicate, Ltd., in West Africa; Assistant Engineer, Southern Pacific Co.
Estacada, Ore., Dec. 14, 1911.

A Non Blister Heel for Walking Shoes*

Capt W. S. Sims, U. S. Navy, has suggested a device which seems to be of considerable value, especially to those officers who suffer from painful blisters on the heel as a result of the physical exercise.

In an ordinary shoe the point of im-

*From U. S. Naval Medical Bulletin for January, 1912 (Washington, D. C.).



A NON-BLISTER HEEL FOR WALKING SHOES

pact is at the edge of the heel, and the blow is transmitted to the heel at the insertion of the tendo achilles. A blister frequently results and is painful to the pedestrian. In this shoe the point of impact is near the middle of the heel, and the blow is felt in the forward or middle part of the heel, where the skin is thick.

By referring to the diagram it is seen that in a shoe with the ordinary heel *A, B, C, D*, the point of impact is at *C*, the main force of the blow being transmitted to the point of the heel, where a blister frequently forms. This blister is commonly present when the shoe fits too tightly, or when a wrinkle in the stocking occurs at this point. In the new shoe heel *E, F, G, B*, the point of impact is *G*, the force of the blow being transmitted to the ball of the heel, and no blister is formed.

Capt Sims says:

> I have been using this kind of a heel on a pair of walking shoes for about three years. It is designed to get rid of the blow at C, where it often makes a blister in the skin of the heel. The new heel transfers the force of the blow from G to the ball of the heel, and never makes a blister. This is especially recommended for heavy men with small feet.

A piece of rubber to replace the removed portion of the heel would no doubt increase the comfort and add to the appearance of the shoe.

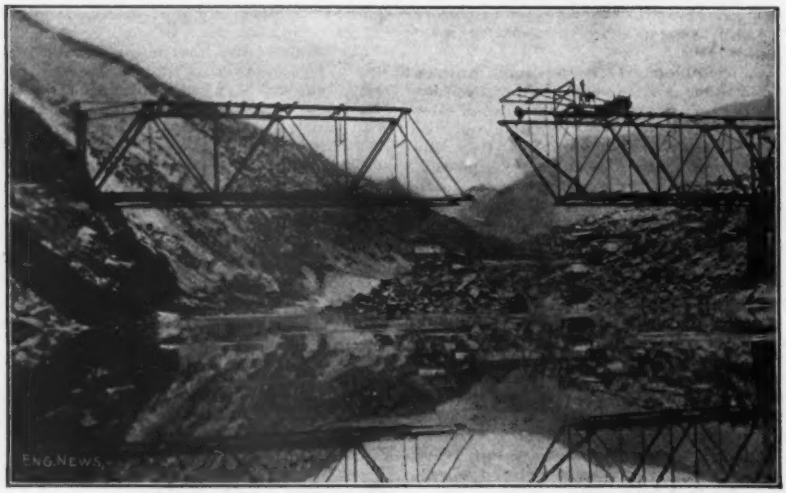
Erecting a 240-ft. Highway Bridge by Cantilevering

The view herewith shows how a 240-ft. bridge over a deep mountain stream was erected near Goff, Idaho, some 45 mi. from a railway. Cantilever erection of such bridges is rare, but in this instance no falsework could be used because the river is over 50 ft. deep and has a rapid current.

The bridge is on the only north-south state highway in Idaho, and is located near Goff, about halfway between Grangeville and New Meadows. It crosses the Salmon River cañon. The wagon road, over which all material had to be transported, is a narrow, crooked thoroughfare in the cañon.

For the cantilever erection, each half of the bridge was anchored back into the bluff by steel cables running over sheaves and adjusted by screw ends. To adjust the span at the bottom chord, the expansion end was fitted with 100-ton hydraulic jacks back of each shoe.

No difficulty was experienced in making the closure. The erection was carried out rapidly; the first steel was placed Dec. 13, 1911, and the first team crossed the bridge Jan. 10, 1912.



CANTILEVER ERECTION OF A 240-FT. HIGHWAY BRIDGE OVER THE SALMON RIVER, GOFF, IDAHO

The bridge was built for the county of Idaho, Idaho, by the Security Bridge Co., of Minneapolis, Minn. A. E. Robinson, of Boise, Idaho, is State Engineer, and Walter Hovey Hill, of Grangeville, Idaho, was Consulting Engineer on the work for the county.

Notes

Directions for Public Land Surveys—In reply to an inquiry as to the present status of public land surveying in the United States, Mr. Fred Dennett, Commissioner of the General Land Office, writes to us as follows:

> The "Manual of Surveying Instructions for the Survey of Public Lands" for 1902 is still in force and is the latest publication on the subject, but a revision of the Manual is in progress and will doubtless be completed before the close of the present year. Contract surveying was discontinued 18 months ago, and the new Manual will, of course, give no instructions relative to the manner or method of entering into contracts or of examination of contract work.

Lintel Beams in Masonry Walls—In our issue of Jan. 25, 1912, a formula for the moment in a wall lintel was given, based on the assumption that the lintel carries the piece of wall included in a triangle whose base is the span and whose height equals one-third the span. A. F. Owen, Marquette Bldg., Chicago, questions this assumption and asks for the authority back of it. He then says:

> Kidder's illustration of such a lintel shows a load bounded by an equilateral triangle, and he states that the beam should be made very stiff.
>
> Is it not good practice to consider the load equal to a square whose base is the span of the lintel?

What assumption of load should be made depends to some extent on the individual case, and is a matter for the engineer's judgment. With a load defined by an equilateral triangle, the formula previously given can be used if the constant is increased proportionately, multiplying it by 3. The equivalent rectangular piece of wall is then of height equal to two-thirds the span, i.e., the center moment is $\frac{2}{3}\frac{w l^2}{8}$, where w is the weight of wall per square foot of face, and l is the span in feet.

Non-freezing Mixtures—The following data are taken from two recent issues of the "Quarterly" of the National Fire Protective Association:

> The amounts of salt and calcium chloride required to keep water from freezing at different temperatures are tabulated below. The salt should be thoroughly dissolved or the results will not be satisfactory. Calcium chloride is said to be superior to sodium chloride in that it does not corrode steel tanks and barrel hoops. Where calcium chloride is used the wooden barrels should first be well coated inside with asphaltum, or a mixture of crude paraffin and resin, to prevent the shrinking of the staves and subsequent leakage.

Common Salt (Sodium Chloride)		Commercial Calcium Chloride	
Pounds per Gallon	Freezing Point, Degrees Fahrenheit	Pounds per Gallon	Freezing Point, Degrees Fahrenheit
½	24 above zero	½	29 above zero
1	18 above zero	1	27 above zero
1½	15 above zero	1½	23 above zero
1½	12 above zero	2	18 above zero
1¾	9 above zero	2½	4 above zero
2	6 above zero	3¼	6 above zero
2½	3 above zero	4	17 above zero
2¾	1 above zero	4½	27 above zero
3	3 below zero	5	39 above zero
3½	8 below zero	5½	54 above zero

Glycerin is recommended for use in chemical fire extinguishers. It has no effect upon metals, but has a tendency to disintegrate rubber. It has been stated, however, that the continued use of glycerin in water renders it liable to a decomposition that would develop compounds having a corrosive action on metals. When using glycerin it should be remembered that one gallon weighs 10½ lb. The following proportions may be used:

Glycerin, pounds per gallon	Temp. solution will withstand
3½	+ 10 F.
5¼	— 10 F.

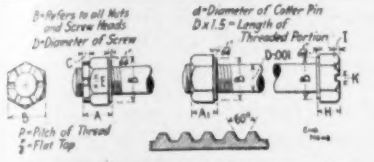
Denatured alcohol has advantages over both glycerin and calcium chloride as a non-freezing element in water solutions, for it has no injurious effect on either metal or rubber. A solution of about 50% is inflammable; however, it would rarely be necessary to have a solution of over 30% alcohol.

A 20%	solution	freezes	at	+ 10 F.
30%	"	"	"	— 5 F.
40%	"	"	"	— 20 F.
50%	"	"	"	— 35 F.

Automobile Nut and Screw Standards*

The Society of Automobile Engineers has lately announced the details of the S. A. E. screw standard, which supplants the screw standard adopted by the Association of Licensed Automobile Manufacturers, in April, 1906.

The United States standards for bolts, nuts and screw-threads were established


B=Across Flats of Nuts and Screw Heads
D=Diameter of Screw
d=Diameter of Cutter Pin
D x 1.5 = Length of Threaded Portion
P=Pitch of Thread
⅛=Flat Top

D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
P	28	24	24	20	20	18	18	16	16	14	14	12	12	12	12
A	5/16	25/64	15/32	35/64	5/8	41/64	23/32	47/64	13/16	59/64	1	1 1/32	1 1/16	1 5/32	1 1/4
A_1	7/32	17/64	21/64	3/8	7/16	31/64	35/64	39/64	23/32	41/64	23/32	25/32	29/32	1 1/32	1 5/32
B	7/16	1/2	9/16	5/8	3/4	7/8	15/16	1	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16
C	1/16	1/16	1/8	1/8	1/8	1/8	1/4	1/4	1/4	1/4	1/4	1/4	1/4	3/8	3/8
E	5/64	1/16	1/8	1/8	1/8	1/8	1/8	5/32	5/32	5/32	5/32	7/32	7/32	1/4	1/4
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	39/64	21/32	3/4	27/32	15/16	1 1/32	1 1/8
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/4	1/4
K	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/16	1/16
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8	11/64	11/64	13/64	13/64

SCREW-THREAD, HEAD AND NUT STANDARDS OF THE SOCIETY OF AUTOMOBILE ENGINEERS

All dimensions given in inches.
All heads and nuts to be "semi-finish."
The standard material for screws and nuts is steel of tensile strength not less than 100,000 lb. per sq.in.; elastic limit not less than 60,000 lb. per sq.in.
Screws, screw-heads and plain nuts are left soft, but castle nuts are case-hardened.
United States standard pitches are to be used for screw threads in other materials, such as cast-iron, brass, bronze or aluminum.
Body diameters of screws must not exceed the dimension given on the drawing, 0.001in. less than the nominal diameter, but may be less than this by 0.002in.
Nuts should be a good fit without perceptible shake.
Taps shall be between 0.002in. and 0.003in. large and drills of the following sizes shall be used with the corresponding taps:

Sizes of taps	Drill sizes, in inches
1/4 in. x 28 threads	3
5/16 " x 24 "	I
3/8 " x 24 "	Q
7/16 " x 20 "	W
1/2 " x 20 "	29/64
9/16 " x 18 "	33/64
5/8 " x 18 "	37/64
11/16 " x 16 "	41/64
3/4 " x 16 "	45/64
7/8 " x 14 "	13/16
1 " x 14 "	59/64
1 1/8 " x 12 "	1 3/64
1 1/4 " x 12 "	1 11/64
1 3/8 " x 12 "	1 19/64
1 1/2 " x 12 "	1 27/64

*No. 5 drill gage.

by the United States Navy Department in May, 1868. About the beginning of the present century, manufacturers of fine machinery found that for a large portion of their work the United States standards for pitch of threads were too coarse and the dimensions of heads and nuts too large. Consequently, where neat appearance and counteraction of the effect of vibration were desired, special fine-pitch screws were made. The number and variety of these special threads led to great confusion, inconvenience and unnecessary expense. To remedy this the A. L. A. M. screw standard was adopted after exhaustive tests, and, with remarkably few exceptions, has proved satisfactory.

Further experience, however, proved the necessity of slight modifications of the A. L. A. M. screw standards, and of extending them to include larger-sized screws. This is the work undertaken by the Society of Automobile Engineers.

The only changes which have been made by the society in the A. L. A. M. standards are as to the distance across flats of the heads and nuts of the ¼-, ⅞- and ¾-in. screws; the changes being from ⅜ to ⅞, from 1⅛ to 1⅛, and from 1⅛ to 1⅛ in., respectively. The A. L. A. M. screw standard did not go beyond 1-in. diameter screws. The S. A. E. standard proceeds by eighths to and including 1½ in. diameter.

The standards have been chosen with consideration of the dimensions of material commonly carried in stock by manufacturers, and, as regards the bolt-head and nut sizes, with consideration of the sizes of openings in standard forged wrenches.

*From a circular sent out by Coker F. Clarkson, secretary, Society of Automobile Engineers, 1451 Broadway, New York City.

A Few Remarks on Wire Rope Clevises

BY CHAS. P. WIWEKE*

The men in the field executing the plans laid down by the men in the office seldom realize the amount of detail information required by the men in the office, unless their experience has covered some office work. A small detail, for example, has caused me a lot of trouble and time. This little detail—the open-type wire-rope clevis—is used a great many times in engineering work. Yet there are few that call for it on their plans that could give any information about it. A look at any of the manufacturers' catalogs will reveal nothing more than the price of it.

The catalogs of all the leading wire-rope makers list the same strength for a wire rope of the same material and given size. It would be a good thing if they would get together and make the same size of clevises and other fittings. The diameter of pin, distance between jaws, and overall length vary considerably with the different makers, for the same size of rope.

I submit a table of drop-forged steel open-type clevises. It will enable one to provide the proper clearances and connections. This table is not original. It is made up from information I have from various leading manufacturers of wire rope. These clevises are well proportioned in themselves and are in proportion to each other. I might explain the last sentence by saying that the pin sizes used by a certain maker were:

Size of clevis	Size of pin
1⅜-in.	1⅜-in.
1¾-in.	1⅞-in.
1⅞-in.	1¾-in.

It is evident that the above are not in proportion.

It would be a very good thing for the original user were these clevises made to a standard by all the wire-rope manufacturers. It would be even yet more to the advantage of the man in the field who has to make the repairs. Just

*Barge Canal Office, Albany, N. Y.

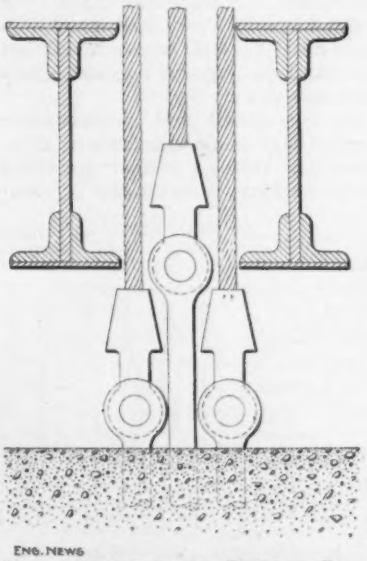


FIG. 1. CONNECTION OF ROPES TO EYE-BOLTS IN A CONCRETE COUNTERWEIGHT
(Counterweight shown in extreme up position.)

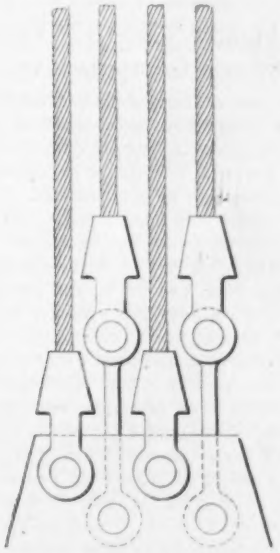
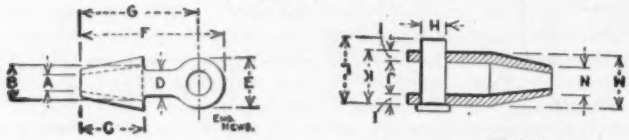


FIG. 2. CONNECTION OF ROPES TO A STEEL LIFT GATE

TWO CLEVIS CONNECTIONS ILLUSTRATING "CLOSE" ARRANGEMENT REQUIRING DIMENSIONS TO BE KNOWN

TABLE OF DIMENSIONS FOR OPEN WIRE-ROPE CLEVISES; DROP-FORGED STEEL.
Compiled by Chas. P. Wiweke



Diam. rope	Socket A	Socket B	Socket C	Tang D	Tang E	Lengths F	Lengths G	Pin diam. H	I	Spread J	Spread K	Spread L	Diam. M	Diam. N	Weight of clevis and pin (lb.)	Cotter	Approx. wt. lead req'd (lb.)
¾	⅞	1	1¾	¾	1¼	4½	3½	¾	¾	¾	1½	1½	1½	⅝	1.1	⅛x1¼	0.18
⅞	1	1⅛	2	1	1½	4⅝	4	1	⅞	1	1⅝	2⅛	1⅝	¾	1.8	⅛x1½	0.29
1	1⅛	1⅜	2½	1⅛	2	6¼	5	1⅛	1	1⅛	2⅛	2⅛	2⅛	1⅞	3.0	¼x1¼	0.75
1⅛	1¼	1⅝	3	1¼	2½	7⅛	6	1¼	1⅛	1¼	2⅝	3⅛	2⅝	1½	4.5	¼x2	1.3
1¼	1⅜	1⅞	3½	1⅜	3	8¼	7	1⅜	1¼	1½	3	3⅝	3	1⅝	7.5	¼x2½	1.4
1	1½	2½	4	2	3½	9⅛	8	1½	1	2	3½	4½	3½	1⅞	12.5	¼x2½	2.3
1½	1⅝	2⅝	4½	2½	4	11	9	2	1⅜	2½	3⅝	4⅝	3⅝	1⅝	17	¼x3	3.2
1¼	1⅝	2⅝	5	2½	4½	12½	10	2	1¼	2½	4⅛	5⅛	4⅛	2⅛	24.5	¼x3½	4.2
1⅜	1⅝	2⅝	5	2½	4½	12½	10	2	1⅜	2½	4⅛	5⅛	4⅛	2⅛	24.5	¼x3½	4.2
1½	1⅞	3⅛	6	3	5½	15½	12½	2½	1½	3	5½	6½	5½	2⅝	43.5	¼x3½	5
1⅝	1⅞	3⅛	6	3	5½	15½	12½	2½	1⅝	3	5½	6½	5½	2⅝	43.5	¼x3½	5

imagine that a clevis has to be replaced. The man in the field does not know who made the original one, so he sends an order to any reputable manufacturer for, say, a 1-in. open clevis. The plate to which it connects has a hole for a 1⅞-in. pin and the plate is 2 in. thick, the clevis being as shown in the table. The clevis he orders may have a pin 1⅝ in. in dia. and a distance between jaws of 1½ in. He would have a nice job attaching that! The probabilities are that he would take the old one to the nearest blacksmith and tell him to forge one as near like it as he could.

The table gives the approximate weight of the clevis and pin as well as the weight of lead required to lead it in place. This will be found very handy where the work is awarded on the pound basis.

The sketches, Figs. 1 and 2, illustrate a few close connections, where it was necessary to know the size of clevis to be used.

A Handy Table for Earthwork Computations

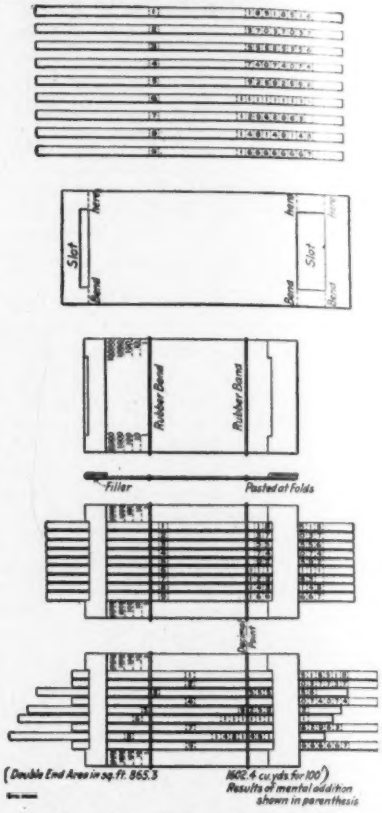
Methods of computing earthwork are almost as numerous as methods of interpolating contours, but the table reproduced herewith is unusual in having the great advantage of compactness. M. H. Peck (6426 Duncan Street, Oakland, Calif.) describes its use as follows:

In calculating cut or fill by the method of average end areas, the following table and methods are accurate to any desired degree, nearly or quite as rapid as the slide-rule, and used with the slide-rule give a perfect check. The table was compiled by T. F. Eastman, assistant city engineer, of Oakland, Calif., from a large table of quantities. The essential point in the small table is that the figures 185 appear as a repeating decimal with coefficients of 1, 2, 3, 4, and so on, the coefficient being the same as the figure in double end area. The table, with the example given, is self-explanatory.

Most of the time required in using the table is expended in writing down the quantities for the different figures of the double end area. The writer has devised two methods for saving on this time. In the first method, each horizontal row in the table was placed on a slip of pasteboard, as shown in the accompanying sketch. A sheet of pasteboard was slotted, bent and marked, as shown in the figure, and the slips were then pushed through the slots. In use, the slips are shifted to bring the figures for the "double end area" into their proper columns, and the quantities under "cu.yd. per 100 ft." added mentally, and the sum written down.

When a number is repeated in the "double end area," two or more numbers whose sum is equal to the required number, may be used instead of the repeated number. For example: If the double end area is 666 sq.ft., 6 may be used in the hundreds' place, 4 and 2 in the tens', and 5 and 1 in the units' place. Or, if the double end area is 711.6 sq.ft., use 7 in the hundreds' place, 8 and 3 in the units', and 6 in the tenths' place. The writer has used this method in calculating several hundred cross-sections, and has found that repeated numbers caused very little delay.

In the second and much superior method, Marchant's calculating machine was used. This is a calculating machine which performs multiplication by successive additions of the multiplicand. For 100-ft. sections the repeating number 185185 was used in the multiplicand, the machine allowing shifting of the decimal point without loss of time. For 50-ft. sections 925925 was used.



AN INSTRUMENT FOR USE IN ADDING FIGURES FROM EARTHWORK TABLE

There are many ways in which the table may be used, but the two described here have been thoroughly tried out in a large dredging contract and found very useful. Quantities were figured by one of these methods and checked by the slide-rule.

GENERAL TABLE—QUANTITIES BY AVERAGE END AREAS

Double End in Square Feet Areas	Hundreths	Tenths	Cubic Yards per 100 Feet: 1 place	2 places	3 places	4 places	5 places	6 places	7 places	8 places	9 places	10 places	11 places	12 places	13 places	14 places	15 places
1			1	8	5	1	8	5	1	8	5	1	8	5	1	8	5	1
2			3	7	0	3	7	0	3	7	0	3	7	0	3	7	0	3
3			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4			7	4	0	7	4	0	7	4	0	7	4	0	7	4	0	7
5			9	2	5	9	2	5	9	2	5	9	2	5	9	2	5	9
6		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7		1	2	9	6	2	9	6	2	8	1	4	8	1	4	8	1	4
8		1	4	8	1	4	8	8	1	9	6	2	9	6	2	9	6	2
9		1	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Vertical lines show position of decimal point for yardage, to any degree of accuracy, of numbers in left-hand column, according to their position as they appear in the given double end area.

Compiled by T. F. Eastman, Aug. 2, 1908.

Example: Given a prism 100 ft. long.
Area 335.7 sq.ft. on one end.
Area 529.6 sq.ft. on other end.

865.3 double end area
800 decimal on "3 place" line
60 decimal on "2 place" line
5 decimal on "1 place" line
0.3 decimal on "tenths" line

865.3 double end area for 100 ft. long

Opposite 8 take out direct 1481.48 cu.yd.
Opposite 6 take out direct 111.11 cu.yd.
Opposite 5 take out direct 9.26 cu.yd.
Opposite 3 take out direct 0.56 cu.yd.

1602.41 cu.yd.

Intricate Survey Work for a New Railway Terminal

Survey work of unusual character was required in laying out the new passenger terminal of the Chicago & Northwestern Ry., at Chicago. W. C. Armstrong, terminal engineer of the railway, described the novel methods used in these surveys recently in a general paper on the new station read before the Western Society of Engineers. The essential element of the method is a thoroughgoing application of the coördinate method, but with the novelty of defining lines by equations instead of defining points by latitudes and departures.

The following extracts from the paper explain the method clearly:

The property surveys involved in this work were made by the Greeley-Howard Co., of Chicago. Lines were run in the streets or on the sidewalks and the corners of each block were defined by crosses cut in the sidewalks, 5 ft. either way from the street lines. The blocks were then subdivided, the actual dimensions of each lot being fixed in proportion to its recorded dimensions, as in most cases blocks were found to either overrun or fall short of their recorded dimensions. These surveys were checked by the Engineering Department of the railway company, the various street and block lines being tied together in some form of closed figure and the accuracy of the work proved by traversing.

The latitudes and departures of coördinates were referred to a system of coordinate axes, so located that the entire territory involved would lie in the first quadrant. The axis of "X," running east and west, was located in Madison St., and the axis of "Y," running north and south, was located in the vicinity of Ashland Ave. The equation of each block line or other line, the location of which was desired, was then established with reference to these coördinate axes. Coördinates of any point on any line could then be determined, or the intersection of two lines could be fixed by equating their respective equations with each other and solving the resultant equation for the required coördinates.

After the map was completed, all track locations were projected upon it and fixed in position by establishing the equations of tangents and curves with reference to the same coördinate axes. Intersections of track lines with street lines were determined by the combination of their respective equations. The location of all lines of columns for the support of structures and the individual columns in these lines were also fixed in the same manner. It was necessary that the field work of these surveys be made with extreme accuracy and all calculations of same carefully checked, for the location of all structures was dependent upon the accuracy of the field work and calculations.

It was impossible to make direct measurements for tracks and structures. No center lines of tracks could be run, for the reason that buildings which had not been removed obstructed the lines of sight. Locations for structures had to be established from indirect measurements and calculations therefrom. This was true of practically all structures upon the approaches, and it was not until many of them were built that the buildings were all removed and the accuracy of the calculations could be verified by running center lines.

Some additional particulars of the methods employed in making this extensive survey were given in a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors by S. N. Howard, of the surveying company mentioned above. From this we quote the following:

The survey covered a total of 42 city blocks. The field work was carried out by two parties of three and four men each, using combination transits with verniers reading to half minutes. The measurements were made with 100-ft. steel tapes, and were repeated to ensure accuracy.

After a search for our notes of old surveys in this territory, the street lines were run in accordance with these notes, and such other evidence as could be found on the ground. The street lines were notched in the curbs at each street, and the location of buildings at street and alley corners taken. An offset (usually 5 ft.) from the intersection of the street lines was notched in the stone and cement walks; where the walks were of wood, nails were placed at this offset.

A careful measurement of each block was made on street and alley lines, and the occupation of various kinds, such as buildings, fences, curbs, or anything which was apparently intended to be on a lot line, was noted. The angle between street lines at each block corner was measured to the nearest half minute, and the block corners were located with reference to a straight line.

A plan was made on a scale of 100 ft. to the inch, showing the measurement of the blocks, angles, and the marking of the street lines and the location of buildings at the street corners. This we termed the "monument survey." Another plan was made on a scale of 50 ft. to the inch, showing the kind, size, number of stories and approximate locations of all buildings on the lots, not acquired by the railway company at the time of beginning the survey. This was plotted in the field on rough paper and finished plans were made in the office.

Afterward a careful location was made of the occupation on the lots which were to go to condemnation, and plans made on a scale of 20 ft. or 10 ft. to the inch, depending on the amount of detail to be shown. In the portion running northwest from Kinzie St., where the railway took a strip running diagonally through the blocks, the plans showed the location of the right-of-way lines with reference to lot corners; also the area in square feet of that part of each ownership taken by the railway and of the portion remaining.

The plans were all made on tracing cloth, and numerous prints made; these were mostly blue line prints, with the streets and right-of-way colored.

We found errors such as we constantly experience in this sort of work: streets as occupied were of greater or less width than shown of record; streets crooked where they should be straight; block measurements showing varying ratios of surplus and interior occupation, not located at the proportionate distance from the streets. All these things have to be taken into account, and the lines so adjusted as to agree as nearly as possible with the occupation, and with the way it was laid out.

Photographic Reproduction of Tracings

By G. W. Gilkison*

Engineers very often find it necessary to have letter-size reproductions of tracings. A very cheap and simple method of making a reproduction is as follows:

Preparing the Tracing—The tracing should be gone over, making all lines and letters opaque. When ready, pick out a window (preferably one facing the north) that is larger than the tracing, so that no shadows will be cast on the edges, and in front of this stretch a sheet of tracing paper or cloth. Over this stretch the tracing to be reproduced, being careful to remove all wrinkles from both diffuser and drawing. If this is properly done the light should be evenly distributed and there should be no shadows.

Exposure—To obtain an idea of the exposure, hold an actinometer, face to the window, and note the time as per instructions. Make about four exposures on a plate by pulling the slide out different distances, using the smallest stop. When developed, if the correct exposure is not within the limits chosen, try again. After the correct exposure has been found, note the relation to the actinometer time. This relation will be a constant and can be applied to all actinometer times to find the exposure, provided the same plate, and stop are used.

Developing—A negative with contrast is desired. This may be had by using Cramer's contrast plates and Eastman's Hydrochinone developer. Mix as directed, making the solution weaker if anything, as this tends to give contrast. With the above plate, develop until the

*Provo, Utah.

image begins to show on the glass side, when, if properly exposed, the plate should be nearly opaque.

REMARKS — No special apparatus is necessary. A 10x12-in. box camera with a good lens and a few trays and bottles will do the work. It pays to get good negatives; this is all in the exposure. By using the smallest stop, good definition is obtained, the exposure is lengthened and can be more accurately timed.

Strength Values for Structural Timbers

The safe values to be used for the unit stresses in structural timber are difficult of determination, on account of the great variation in the rupturing strengths of different pieces of wood of the same species. Probably the best compilation of such safe stresses is that made by the American Railway Engineering Association in 1909 (then the American Railway Engineering and Maintenance of Way Association) and reprinted in ENGINEERING NEWS, Mar. 25, 1909, p. 310. For the benefit of those engineers who wish to have a record of the ultimate strengths of various timbers, from which to deduce their own safe unit-stress values, the U. S. Forest Service has recently issued a circular*, by McGarvey Cline, of the Service, which we reprint on this and the following page.

The following tables bring together in condensed form the average strength values resulting from a large number of tests made by the U. S. Forest Service on the principal structural timbers of the United States. These results are more completely discussed in other publications of the Service, while most of them have also been furnished to the American Railway Engineering and Maintenance of Way Association and to various committees charged with the revision of the building laws of different cities. Their publication in the present form makes them available for quick reference by engineers, architects, builders and other users of structural timbers.

The tests were made at the laboratories of the Forest Service, in coöperation with the following universities: Purdue University, Yale Forest School, University of California, University of Oregon, University of Washington, University of Colorado, and University of Wisconsin.

Tables I and II give the average results obtained from tests on green material, while Tables III and IV give average results from tests on air-seasoned material. The small specimens, which were invariably 2x2 in. in cross-section, were free from defects such as knots, checks and cross grain; all other specimens were representative of material secured in the open market. The relation of stresses developed in different structural forms to those developed in

*Circular 189, U. S. Department of Agriculture Forest Service. "Strength Values for Structural Timbers," by McGarvey Cline, Director, Forest Products Laboratory; Washington, 1912.

TABLE I. BENDING TESTS ON GREEN MATERIAL

Species	Sizes: Cross-section	Sizes: Span	Number of tests	Percent. of moisture	Rings per inch	Fiber Stress at Elastic Limit: Average per square inch	Fiber Stress at Elastic Limit: Ratio to 2x2"	Mod. of Rupture: Average per square inch	Mod. of Rupture: Ratio to 2x2"	Mod. of Elast.: Average per square inch 1000	Mod. of Elast.: Ratio to 2x2"	Calculated Shear: Average per square inch	Calculated Shear: Ratio to 2x2"
	In.	In.				Lb.		Lb.		Lb.		Lb.	
Longleaf pine	12x12	138	4	28.6	9.7	4099	0.83	6710	0.74	1523	0.99	261	0.86
	10x16	168	4	26.8	16.7	4193	0.85	6453	0.71	1626	1.05	306	1.01
	8x16	156	7	28.4	14.6	3147	0.64	5439	0.60	1368	0.89	390	1.29
	6x16	132	1	40.3	21.8	4120	0.83	6460	0.71	1190	0.77	378	1.25
	6x10	180	1	31.0	6.2	3580	0.72	6500	0.72	1412	0.92	175	0.58
	6x 8	180	2	27.0	8.2	3735	0.75	5745	0.63	1282	0.83	121	0.40
	2x 2	30	15	33.9	14.1	4950	1.00	9070	1.00	1540	1.00	303	1.00
Douglas fir	8x16	180	191	31.5	11.0	3968	0.76	5983	0.72	1517	0.95	269	0.81
	6x 8	180	84	30.1	10.8	3693	0.71	5178	0.63	1533	0.96	172	0.52
	2x12	180	27	35.7	20.3	3721	0.71	5276	0.64	1642	1.03	256	0.77
	2x10	180	26	32.9	21.6	3160	0.60	4699	0.57	1593	1.00	189	0.57
	2x 8	180	29	33.6	17.6	3593	0.69	5352	0.65	1607	1.01	171	0.51
	2x 2	24	568	30.4	11.6	5227	1.00	8280	1.00	1597	1.00	333	1.00
Douglas fir (fire killed)	8x16	180	30	36.8	10.9	3503	0.80	4994	0.64	1531	0.94	330	1.19
	2x12	180	32	34.2	17.7	3489	0.80	5085	0.66	1624	0.99	247	0.89
	2x10	180	32	38.9	18.1	3851	0.88	5359	0.69	1716	1.05	216	0.78
	2x 8	180	31	37.0	15.7	3403	0.78	5305	0.68	1676	1.02	169	0.61
	2x 2	30	290	33.2	17.2	4360	1.00	7752	1.00	1636	1.00	277	1.00
Shortleaf pine	8x16	180	12	39.5	12.1	3185	0.73	5407	0.70	1438	1.03	362	1.30
	8x14	180	12	45.8	12.7	3234	0.74	5781	0.75	1494	1.07	338	1.21
	8x12	180	24	52.2	11.8	3265	0.75	5503	0.71	1480	1.06	277	1.07
	6x 8	180	24	47.8	11.5	3519	0.81	5732	0.74	1485	1.06	185	0.72
	2x 2	30	254	51.7	13.6	4350	1.00	7710	1.00	1395	1.00	258	1.00
Western larch	8x16	180	32	51.0	25.3	3276	0.77	4632	0.64	1272	0.97	298	1.11
	8x12	180	30	50.3	23.2	3376	0.79	5286	0.73	1331	1.02	254	0.94
	6x 8	180	14	56.0	25.6	3528	0.83	5331	0.74	1432	1.09	169	0.63
	2x 2	28	189	46.2	26.2	4274	1.00	7251	1.00	1310	1.00	269	1.00
Loblolly pine.	8x16	180	17	45.8	6.1	3094	0.75	5394	0.69	1406	0.98	383	1.44
	5x12	180	94	60.9	5.9	3030	0.74	5028	0.64	1383	0.96	221	0.83
	2x 2	30	44	70.9	5.4	4100	1.00	7870	1.00	1440	1.00	265	1.00
Tamarack	6x12	162	15	57.6	16.6	2914	0.75	4500	0.66	1202	1.05	255	1.11
	4x10	162	15	43.5	11.4	2712	0.70	4611	0.68	1238	1.08	209	0.91
	2x 2	30	82	38.8	14.0	3875	1.00	6820	1.00	1141	1.00	229	1.00
Western hemlock	8x16	180	39	42.5	15.6	3516	0.80	5296	0.73	1445	1.01	261	0.92
	2x 2	28	52	51.8	12.1	4406	1.00	7294	1.00	1428	1.00	284	1.00
Redwood	8x16	180	14	86.5	19.9	3734	0.79	4492	0.64	1016	0.96	300	1.21
	6x12	180	14	87.3	17.8	3787	0.80	4451	0.64	1068	1.00	224	0.90
	7x 9	180	14	79.8	16.7	4412	0.93	5279	0.76	1324	1.25	199	0.80
	3x14	180	13	86.1	23.7	3506	0.74	4364	0.62	947	0.89	255	1.03
	2x12	180	12	70.9	18.6	3100	0.65	3753	0.54	1052	0.99	187	0.75
	2x10	180	13	55.8	20.0	3285	0.69	4079	0.58	1107	1.04	169	0.68
	2x 8	180	13	63.8	21.5	2989	0.63	4063	0.58	1141	1.08	134	0.54
	2x 2	28	157	75.5	19.1	4750	1.00	6980	1.00	1061	1.00	248	1.00
Norway pine.	6x12	162	15	50.3	12.5	2305	0.82	3572	0.69	987	1.03	201	1.17
	4x12	162	18	47.9	14.7	2648	0.94	4107	0.79	1255	1.31	238	1.38
	4x10	162	16	45.7	13.3	2674	0.95	4205	0.81	1306	1.36	198	1.15
	2x 2	30	133	32.3	11.4	2808	1.00	5173	1.00	960	1.00	172	1.00
Red spruce	2x10	144	14	32.5	21.9	2394	0.66	3566	0.60	1180	1.02	181	0.80
White spruce.	2x 2	26	60	37.3	21.3	3627	1.00	5900	1.00	1157	1.00	227	1.00
	2x10	144	16	40.7	9.3	2239	0.72	3288	0.63	1081	1.08	166	0.83
	2x 2	26	83	58.3	10.2	3090	1.00	5185	1.00	998	1.00	199	1.00

TABLE II. COMPRESSION AND SHEAR TESTS ON GREEN MATERIAL

Species	Compression ‖ to grain: Size of specimen	Number of tests	Per cent. of moisture	Cr. str. at E. L., per sq. in.	Mod. of Elas., per sq. in. 1000	Cr. str. at max. ld., per sq. in.	Compression ⊥ to grain: Stress area	Height	Number of tests	Per cent. of moisture	Cr. str. at E. L., per sq. in.	Shear: Number of tests	Per cent. of moisture	Shear strength
	In.			Lb.	Lb.	Lb.	In.	In.			Lb.			Lb.
Longleaf pine	4x4	46	26.3	3480	....	4800	4x4	4	22	25.3	568	44	21.8	973
	2x2	14	34.7	....	....	4400	....	....	....	....	....	....	....	....
Douglas fir	6x6	515	30.7	2780	1181	3500	4x8	16	259	30.3	570	531	29.7	765
	5x6	170	30.9	2720	2123	3490	....	....	....	....	....	....	....	....
	2x2	902	29.8	3500	1925	4030	....	....	....	....	....	....	....	....
Douglas fir (fire-killed)	6x6	108	34.8	2620	1801	3290	6x8	16	24	33.7	368	77	35.8	631
	2x2	204	37.9	....	....	3430	....	....	....	....	....	....	....	....
Shortleaf pine	6x6	95	41.2	2514	1565	3436	5x8	16	12	37.7	361	179	47.0	704
	5x8	23	43.5	2241	1529	3423	5x8	14	12	42.8	366	....	....	....
	2x2	281	51.4	....	....	3570	5x8	12	24	53.0	325	....	....	....
	....	....	....	....	....	....	5x5	8	24	47.0	344	....	....	....
	....	....	....	....	....	....	2x2	2	277	48.5	400	....	....	....
Western larch	6x6	107	49.1	2675	1575	3510	6x8	16	22	43.6	417	179	40.7	700
	2x2	491	50.6	3026	1545	3696	6x8	12	20	40.2	416	....	....	....
	....	....	....	....	....	....	4x6	6	53	52.8	478	....	....	....
	....	....	....	....	....	....	4x4	4	30	50.4	472	....	....	....
Loblolly pine	8x8	14	63.4	1560	365	2140	8x4	8	16	67.2	392	121	83.2	630
	8x8	18	60.0	2430	691	3560	4x4	8	38	44.6	546	....	....	....
	2x2	53	74.0	....	....	3240	....	....	....	....	....	....	....	....
Tamarack	6x7	4	49.9	2332	1432	3032	....	....	....	....	....	24	39.2	668
	4x7	6	27.7	2444	1334	3360	....	....	....	....	....	....	....	....
	2x2	165	36.8	....	....	3190	....	....	....	....	....	....	....	....
Western hemlock	6x6	82	46.6	2905	1617	3355	6x4	6	30	48.7	434	54	65.7	630
	2x2	131	55.6	2938	1737	3392	....	....	....	....	....	....	....	....
Redwood	6x6	34	83.6	3194	1240	3882	6x8	16	13	86.7	473	148	84.2	742
	2x2	143	72.1	3490	1222	3980	6x6	12	14	83.0	424	....	....	....
	....	....	....	....	....	....	6x7	9	13	74.7	477	....	....	....
	....	....	....	....	....	....	6x3	14	13	75.6	411	....	....	....
	....	....	....	....	....	....	6x2	12	12	66.5	430	....	....	....
	....	....	....	....	....	....	6x2	10	11	55.0	423	....	....	....
	....	....	....	....	....	....	6x2	8	12	56.7	396	....	....	....
	....	....	....	....	....	....	2x2	2	186	75.5	569	....	....	....
Norway pine	6x7	5	29.0	1928	905	2404	....	....	....	....	....	20	26.7	589
	4x7	8	28.4	2154	1063	2652	....	....	....	....	....	....	....	....
	2x2	178	26.8	....	....	2504	....	....	....	....	....	....	....	....
Red spruce	2x2	58	35.4	....	....	2750	2x2	2	43	31.8	310	30	32.0	758
White spruce	2x2	84	61.0	....	....	2370	2x2	2	46	50.4	270	40	58.0	651

TABLE III. BENDING TESTS ON AIR-SEASONED MATERIAL

Species	Sizes: Cross-section	Sizes: Span	Number of tests	Per cent. of moisture	Rings per inch	Fiber Stress at Elastic Limit: Average per square inch	Fiber Stress at Elastic Limit: Ratio to 2x2"	Mod. of Rupture: Average per square inch	Mod. of Rupture: Ratio to 2x2"	Mod. of Elast.: Average per square inch	Mod. of Elast.: Ratio to 2x2"	Calculated Shear: Average per square inch	Calculated Shear: Ratio to 2x2"
	In.	In.				Lb.		Lb.		1000 Lb.		Lb.	
Longleaf pine	8x16	180	5	22.2	16.0	3390	0.50	4.274	0.37	1747	1.00	288	0.75
	6x16	132	1	23.4	17.1	3470	0.51	6,610	0.57	1501	0.86	388	1.01
	6x10	177	2	19.0	8.8	4560	0.68	7,880	0.68	1722	0.99	214	0.56
	4x11	180	1	18.4	23.9	3078	0.46	8,000	0.69	1 60	0.95	251	0.66
	6x 8	177	6	20.0	13.7	4227	0.63	8,196	0.71	1634	0.94	177	0.46
	2x 2	30	17	15.9	13.9	6750	1.00	11,520	1.00	1740	1.00	383	1 00
Douglas fir	8x16	180	91	20.8	13.1	4563	0.68	6,372	0.61	1549	0.91	269	0.64
	5x 8	180	30	14.9	12.2	5065	0.76	6,777	0.65	1853	1.09	218	0.52
	2x 2	24	211	19.0	16.4	6686	1.00	10,378	1.00	1695	1.00	419	1.00
Shortleaf pine	8x16	180	3	17.0	12.3	4220	0.54	6,030	0.50	1517	0.85	398	0.98
	8x14	180	3	16.0	12.3	4253	0.55	5,347	0.44	1757	0.98	307	0.76
	8x12	180	7	16.0	12.4	5051	0.65	7,331	0.60	1803	1.01	361	0.89
	5x 8	180	6	12.2	22.5	7123	0.92	9,373	0.77	1985	1.11	301	0.74
	2x 2	30	67	14.2	13.7	7780	1.00	12,120	1.00	1792	1.00	404	1.00
Western larch	8x16	180	23	18.3	21.9	3343	0.57	5,440	0.53	1409	0.90	349	0.96
	8x12	180	29	17.8	23.4	3631	0.62	6,186	0.60	1549	0.99	295	0.81
	5x 8	180	10	13.6	27.6	4730	0.80	7,258	0.71	1620	1.04	221	0.61
	2x 2	30	240	16.1	26.8	5880	1.00	10,254	1.00	1564	1.00	364	1.00
Loblolly pine	8x16	180	14	20.5	7.4	4195	0.81	6,734	0.72	1619	1.10	462	1.45
	6x16	126	4	20.2	5.0	2432	0.47	4,295	0.46	1324	0.90	266	0.84
	6x10	174	3	21.3	4.7	3100	0.60	6,167	0.66	1449	0.99	173	0.54
	4x12	174	4	19.8	4.7	2713	0.52	5,745	0.61	1249	0.85	185	0.58
	8x 8	180	9	22.9	4.9	2903	0.56	4,557	0.48	1136	0.77	93	0.29
	6x 7	144	2	21.1	5.0	2990	0.58	4,968	0.53	1286	0.88	116	0.36
	4x 8	132	8	19.5	9.1	3384	0.65	6,194	0.66	1200	0.82	196	0.62
	2x 2	30	123	17.6	6.6	5170	1.00	9,400	1.00	1467	1.00	318	1.00
Tamarack	6x12	162	5	23.0	15.1	3434	0.45	5,640	0.43	1330	0.82	318	0.75
	4x10	162	4	14.4	9.7	4100	0.54	5,320	0.41	1356	0.84	252	0.59
	2x 2	30	47	11.3	16.2	7630	1.00	13,080	1.00	1620	1.00	425	1.00
Western hemlock	8x16	180	44	17.7	17.8	4398	0.69	6,420	0.62	1737	1.04	406	1 06
	2x 2	28	311	17.9	19.4	6333	1.00	10,369	1.00	1666	1.00	382	1.00
Redwood	8x16	180	6	26.3	22.4	3797	0.79	4,428	0.57	1107	0.96	294	1.05
	6x12	180	6	16.1	17.7	3175	0.66	3,353	0.43	728	0.64	167	0.60
	7x 9	180	6	15.9	15.2	3280	0.69	4,002	0.51	1104	0.96	147	0.53
	3x14	180	6	13.1	24.4	....	....	5,033	0.64	....	....	291	1 04
	2x12	180	5	13.8	14.4	3928	0.82	5,336	0.68	1249	1.09	260	0.93
	2x10	180	5	13.8	24.8	3757	0.79	4,606	0.59	1198	1.05	186	0.67
	2x 8	180	6	13.7	20.7	4314	0.90	5,050	0.65	1313	1.15	166	0.60
	2x 2	28	122	15.2	18.8	4777	1.00	7,798	1.00	1146	1.00	279	1.00
Norway pine	6x12	162	5	16.7	8.1	2968	0.56	5,204	0.61	1123	0.97	286	1.02
	4x10	162	5	13.7	12.0	5170	0.98	6,904	0.82	1712	1.48	317	1.13
	2x 2	30	60	14.9	11.2	5280	1.00	8,470	1.00	1158	1.00	281	1.00

TABLE IV. COMPRESSION AND SHEAR TESTS ON AIR-SEASONED MATERIAL

Species	Compression ‖ to grain: Size of specimen	Compression ‖ to grain: Number of tests	Compression ‖ to grain: Per cent. of moisture	Compression ‖ to grain: Cr. str. at E. L., per sq.in.	Compression ‖ to grain: Mod. of Elas., per sq.in.	Compression ‖ to grain: Cr. str. at max. ld., per sq.in.	Compression ⊥ to grain: Stress area	Compression ⊥ to grain: Height	Compression ⊥ to grain: Number of tests	Compression ⊥ to grain: Per cent. of moisture	Compression ⊥ to grain: Cr. str. at E. L., per sq.in.	Shear: Number of tests	Shear: Per cent. of moisture	Shear: Shear strength per sq.in.
	In.			Lb.	1000 Lb.	Lb.	In.	In.			Lb.			Lb.
Longleaf pine	4x5	46	26.3	3480	....	4800	4x5	4	22	25.1	572	52	20.2	984
Douglas fir	6x6	259	20.3	3271	1038	4258	4x8	16	44	20.8	732	465	22.1	822
	2x2	247	18.7	3842	1084	5002	4x8	10	32	18.1	584	...	....	....
	....	....	....	....	....	....	4x4	8	51	20.2	638	...	....	....
	....	....	....	....	....	....	4x4	6	49	24.0	613	...	....	....
	....	....	....	....	....	....	4x4	4	29	24.8	603	...	....	....
Shortleaf pine	6x6	29	15.7	4070	1951	6030	8x5	16	4	17.8	725	85	....	1135
	2x2	57	14.2	....	....	6380	8x5	14	3	16.3	757	...	....	....
	....	....	....	....	....	....	8x5	12	5	15.1	730	...	....	....
	....	....	....	....	....	....	5x5	8	6	13.0	918	...	....	....
	....	....	....	....	....	....	2x2	2	57	13.9	926	...	....	....
Western larch	6x6	112	16.0	....	....	5445	8x6	16	17	18.8	491	193	15.0	905
	4x4	81	14.7	....	....	6161	8x6	12	18	17.6	526	...	....	....
	2x2	270	14.8	....	....	5934	5x4	8	22	13.3	735	...	....	....
Loblolly pine	6x6	23	....	3357	1693	5005	8x5	16	12	19.8	602	156	11.3	1115
	5x5	10	22.4	2217	545	2950	8x5	8	7	22.9	679	...	....	....
	4x8	8	19.4	3010	633	3920	4x5	8	8	19.5	715	...	....	....
	2x2	69	....	....	....	5547	...	..	...	....	...	...	....	....
Tamarack	6x7	3	15.7	2257	1042	3323	2x2	2	57	16.2	697	60	14.0	879
	4x7	3	13.6	3780	1301	4823	...	..	...	....	...	...	....	....
	4x4	57	14.9	3386	1353	4346	...	..	...	....	...	...	....	....
	2x2	66	14.6	....	....	4790	...	..	...	....	...	...	....	....
Western hemlock	6x6	102	18.6	4840	2140	5814	7x6	15	25	18.2	514	131	17.7	924
	2x2	463	17.0	4560	1923	5403	6x6	6	26	16.8	431	...	....	....
	....	....	....	....	....	....	4x4	4	6	15.9	488	...	....	....
Redwood	6x6	18	16.9	....	....	4276	8x6	16	5	25.4	548	95	12.4	671
	2x2	115	14.6	....	....	5119	6x6	12	6	14.7	610	...	....	....
	....	....	....	....	....	....	7x6	9	5	14.8	500	...	....	....
	....	....	....	....	....	....	3x6	14	2	12.6	470	...	....	....
	....	....	....	....	....	....	2x6	12	2	16.2	498	...	....	....
	....	....	....	....	....	....	2x6	10	4	14.3	511	...	....	....
	....	....	....	....	....	....	2x6	8	2	13.2	429	...	....	....
	....	....	....	....	....	....	2x2	2	145	13.8	564	...	....	....
Norway pine	6x7	4	15.2	2670	1182	4212	2x2	2	36	10.0	924	44	11.9	1145
	4x7	2	22.2	3275	1724	4575	...	..	...	....	...	...	....	....
	4x4	55	16.6	3048	1367	4217	...	..	...	....	...	...	....	....
	2x2	44	11.2	....	....	7550	...	..	...	....	...	...	....	....

the small clear specimens is shown for each factor in the column headed "Ratio to 2x2". Tests to determine the mechanical properties of different species are often confined to small clear specimens. The ratios included in the tables may be applied to such results in order to approximate the strength of the species in structural sizes, and containing the defects usually encountered, when tests on such forms are not available.

A comparison of the results of tests on seasoned material with those from tests on green material shows that, without exception, the strength of the 2x2-in. specimens is increased by lowering the moisture content, but that increase in strength of other sizes is much more erratic. Some specimens, in fact, show an apparent loss in strength, due to seasoning. If structural timbers are seasoned slowly, in order to avoid excessive checking, there should be an increase in their strength. In the light of these facts, it is not safe to base working stresses on results secured from any but green material.

Standardization of Motor Trucks is being undertaken by a committee of the American Society of Automobile Engineers, of which Mr. William P. Kennedy, of the American Locomotive Co., is chairman. At a recent meeting of this committee it was decided tentatively that a motor truck should be capable of rendering normal or continuous service under its tonnage rating and should have an overload capacity for temporary or emergency service of 25% above its normal capacity. A vote of the committee on desirable speed of trucks of various capacities resulted in the following:

For 1-ton trucks	.....	15	miles per hour	
" 2-ton "	.....	12	" "	"
" 3-ton "	.....	10	" "	"
" 4-ton "	.....	9	" "	"
" 5-ton "	.....	8	" "	"

These ratings are only tentative and may be subsequently modified.

A Standard Depth of Water for important harbors of the world, to be fixed by international agreement, is to be proposed by C. E. Grunsky, of California, at the International Congress of Navigation, which is to assemble in Philadelphia, on May 23. C. Leemans, a distinguished Dutch engineer, is on record as declaring that the increase in size of vessels in recent years has made harbors of dimensions sufficient to accommodate them almost impossible, financially. Inasmuch as the total cost of water transportation includes the investment in water terminals as well as the cost of operating ships, it is evident that any saving in cost of transportation by the use of larger vessels may be overbalanced by the excessive investments in harbors and wharves for which the public is taxed. Mr. Grunsky contends that the dimensions for the Panama Canal set the extreme limit which should be allowed to govern in fixing harbor depths, especially as the cost of making and maintaining these terminals increases very greatly with each foot increase in depth.

There is enough for the harbor engineers of the world to do in enlarging existing ports to accommodate vessels already built to absorb a vast amount of capital. It is not generally realized that only a very few of the world's seaports, probably less than half a dozen of those of commercial importance, have at present depth sufficient to safely accommodate the largest vessels afloat.

Letters to the Editor

Would It Be Good Economy to Install Isolated Pumps at Public Fountains?

Sir—In a recent article and editorial on the Washington water-works, no mention is made of the fact that during part of the year much water is used for ornamental public fountains—unmetered as far as I know. Is it cheaper to bring water some 16 miles by gravity, pump it onto gravity sand filters, then force it under an almost excessive pressure (for some sections) into the distributing system, part of it to be run from fountains directly into sewers, than to install a small electric or gasoline pumping plant at the fountain?

While I like to see the water play in the fountains, this water seems too expensive, the question of increasing the supply being already up for consideration.

ROBERT CRAIG GREENE.

McGill Bldg., Washington, D. C., Feb. 2.

Failure to Give Credit to Engineers

Sir—I have noticed several articles in your journal showing that engineers throughout the country do not receive recognition for the work they do. I am inclosing an editorial [not reprinted—ED.] on land drainage in the Yellowstone Valley, which appeared in a local paper recently. There isn't a mention made of the engineering end of it, when as a matter of fact, the whole system was originated by us. The land drainage here employed is drainage by interception, and when we began work about six years ago and were looking for information on the subject, we could find nothing whatever showing that this system had been employed anywhere before.

We send you this simply to show that the ignoring of the engineering profession is quite general throughout the country.

HENRY GERHARZ, President,
The Henry Gerharz Engineering Co.

Billings, Mont., Feb. 5, 1912.

The Economics of Justifiable Expenditure on Road Improvement

Sir—Will you permit a short rejoinder to the editorial comment on my communication on "good roads" in your issue of Feb. 8, p. 260?

First, as to underestimating the period of muddy weather during which good roads are advantageous, and as to the saving per ton-mile of haulage when roads are very muddy: The Interstate Commerce Commission's reports give the total annual tonnage of farm and forest products at 200 million tons in round numbers. Assume the average length of haul as 10 miles (which may be too high), then the total ton-miles of road haulage for the whole country is 2 billion ton-miles, or on the two million odd miles of public roads an average of about 1000 tons per annum. Now if 10c. per ton-mile can be saved the year round, good weather and bad, by building hard roads, the annual saving on farm and forest product is $100 per mile of road. Then assuming interest at 5% and maintenance and depreciation at only 5%, or 10% in all, the justifiable expenditure for macadamizing the *average* mile of road is $1000.

But the least that good-roads advocates have estimated good roads to cost is $3000 a mile, and their actual cost has been, as stated in my former letter, $5000 and even more, for "water-bound" macadam. Since the *average* road will warrant spending only $1000, and since this includes the heavily traveled roads, there must be many, many miles of roads in the Far West and elsewhere on which the justifiable expenditure (so far as traffic in farm products is concerned) would be far less than $1000, if the above line of reasoning is correct and the data sound.

As for your argument that the people are generally as willing to be taxed to secure good roads for buggies and automobiles as for hauling farm products to market, that is true, perhaps, in some localities; but what about the ultimate effect of increasing taxes to secure for the community what are really luxuries, when there are so many who find it hard to pay for the necessaries of life?

A. P. C.

Nashville, Tenn., Feb. 13, 1912.

Government vs. Private Engineering

Sir—The discussion in recent issues of ENGINEERING NEWS of the offer of free highway bridge engineering by a federal bureau seems to be getting rather far afield, and we seem to have constituted ourselves a coroner's jury to decide whether the death of competition was due to natural causes or to foul play on the part of one John Doe, alias the Trust. Mr. Bridgman even says that the deceased never existed, as far as highway engineering is concerned.

Even supposing that federal engineering is, by reason of its magnitude, more efficient than private engineering, the fact of the unfair competition and unjust general distribution of the cost of purely local improvements remains. Missionary work by the federal government, if confined to missionary work, is a valuable aid to all concerned. But not all, and I think very few, engineers desire, with Mr. Trautwine, to be tied to a stall in the public crib, however free such a berth might be from the worry and responsibility of individual work.

The bureau in question may, as some of its sponsors have stated, confine its efforts to a field not capable of development by engineers in private practice. If it does, it will do what few of the similar bureaus have done. And when the field shall be developed, there will be no one in the business except the government—a step toward the era of the benevolent public crib. Whenever the bureau of highway bridge engineering finds itself in competition with engineers in private practice (which, notwithstanding Mr. Bridgman, it will do in various parts of the country) it should decline to assist in putting such engineers out of business.

Again, the highways of the United States are not interstate roads, and their control and improvement properly belongs to the county and the state in which they are located.

It is axiomatic in our form of government that when the people really want anything, and want it long enough, and hard enough, they can get it, even in Philadelphia. When the citizens of Vernon Parish, Louisiana, or of Lancaster County, Nebraska, want a graded or macadamized road, with steel bridges and concrete culverts, and care enough about the quality of the construction to ask the federal government to send them an engineer, they can find, within a hundred miles of their county seat, engineers who can qualify for the position and who know the local conditions even better than a civil-service man from Seattle or Boston.

In regard to trusts, or the centralized management of everything, allow me to register an objection to the statement that such organizations are more efficient than individual and competing managements. At first glance it would seem that they should be. But the experience of the American people, and the people of Europe, as well, shows that they are not,

and if left to their own devices, never will be.

A monopoly is able, by sheer brute force, to force its small competitors to its terms. It does not need to be economical to succeed. That most compelling of all incentives to effort, the desire to live, has been eliminated. A man who is of a caliber to make a successful business man is manager of a branch office, and is not vitally concerned beyond keeping his job, which is not always hard to do, as the doors to such opportunities are marked "Pull" more often than "Push." Mere inertia will often keep a man from being fired, even when his duties consist in distributing to the employees in his department the work and instructions he finds on his desk, sent there, of course, by some man higher up. The minor employees usually do their work as well as they know how, because their jobs are as vital, and more uncertain, than under a competitive system.

In all the so called trusts there are hundreds of employees who do not give value received for their salary, and whose resignations would leave no vacancy except in the space provided for their initials on the company's forms.

Mr. Brandeis would not have any difficulty in saving the percentage of expense he offered to save to the railroads of the United States and could do as much or more for any of the large corporations. Neither would it be hard for Mr. Carnegie's active and alert partners to run all around any corporation if fouling were forbidden on the running track.

It is time for the "colossal social force" mentioned by Mr. Flynn to get busy. Let us hope that when the smoke of battle has cleared away, the trusts will not own the government, as they do now, or the government own the trusts, as the "public crib" suggests.

IRA W. DYE.
4021 W. 18th St., Chicago.
Feb. 5, 1912.

Rivers Boards for Sanitary and General Control

Sir—It is refreshing to read such articles as the paper of J. D. Watson on the pollution of the River Tame in your issue of Feb. 8, because, besides the clear and authoritative account of the long litigation between two neighboring English communities on the question of stream pollution, it gives a definite, broad and sensible opinion on the general question. It should receive wide publicity, because it plainly indicates, in my opinion, the way in which these questions should be viewed not only in England, but also in our country.

As early as 1902, in a paper for the American Society of Civil Engineers (Vol. XLIX of the *Transactions*) I urged the advantages of having river boards or controlling authorities both to regulate each stream for low-water and flood-water conditions, as well as to care for its sanitary conditions. The day for constituting such authorities seems in some cases to have already drastically arrived.

The delay in pushing this matter ahead is due, no doubt, to the fact that there is as yet hardly anywhere in our country, with one or two exceptions, a single interest or a combined interest sufficiently strong to consider the necessary effort worth the trouble. Continuous agitation, until there happens something approaching a calamity, seems therefore the only way to keep the question before the public.

Another important subject emphasized by Mr. Watson is the distinction between preventable and inevitable pollution. We should aim at having clean rivers as much as we aim to have clean streets. With all our usual rules and regulations our streets get dirty from preventable and unpreventable sources. The preventable sources of dirt should be controlled so far as possible by enforcing the law, and the remaining dirt should be removed by the street-cleaning department of the city.

Our rivers also are more or less highways of travel; they also collect the dirt from the adjoining areas, and they also get preventable and unpreventable pollutions. Therefore they should also be controlled, first by exercising all practicable means of excluding all preventable pollution, and secondly by establishing a regular system of public cleaning to remove the sources of pollution which are "inevitable." It is now generally recognized by engineers in both Europe and America that there exists such "inevitable" or unpreventable pollution of rivers in every civilized, inhabited and industrial community. The problem before us is at what point to draw the line, the position of which will depend on several conditions, the most important being the cost. Following Mr. Watson in the main we can say that also in our country we should exclude from rivers all sewage and trade wastes that would put them into an offensive condition. Our sanitary battle-cry should be not only "clean streets," but also "clean rivers." Rivers should not only be flushed and cleaned by nature through their periodical freshets, but at suitable times also from mill or other dams, as says Mr. Watson, "by which the sludge is scoured into the streams while they are in their normal condition." We should add that those sludge deposits, which are inevitable and objectionable, should be dredged, and the dredgings removed to points where they are not objectionable. We should endeavor by such dredging to maintain the water's dissolved oxygen content, the chief purifier of river waters, at as high a degree as practicable.

It will often be a question requiring investigation as to whether sludge removal from river bottoms or sludge retention on land will be the less costly treatment to secure clean rivers. In judging of this question we must realize that sludge deposits alone, by their putrefaction, may become a greater source of pollution of a river or estuary than comparatively fresh but screened sewage entering it and carrying the diluted matter in suspension to points sufficiently far away to facilitate both oxidation and unobjectionable deposition.

Mr. Watson, near the end of his excellent article, states what I have considered the foundation of the entire subject, and I repeat it because it can hardly be repeated too often, and because, as soon as fully recognized by the public, it will give us both the rational and economical relief desired. He says:

> I do not despair of seeing the time when each great river will be dealt with as a whole, when a rivers authority will be held responsible by the government for the entire watershed, and will possess authority to determine what degree of purification should be effected by a town or district at the head of a stream; what degree would be acceptable in respect of a town situated on a wide estuary or on tidal rivers.

RUDOLPH HERING.
170 Broadway, New York, Feb. 13, 1912.

The Uses and Levels of the Great Lakes

Sir—In your issue of Dec. 14, 1911, you published an abstract of a paper by Prof. Gardner S. Williamson on "The Uses of the Great Lakes," in which it is stated:

> The great shipping combination at whose behest the waters of Lake Michigan have been already lowered a foot says there must be no more diversion lest the lake be lowered an inch or two and the cargoes of ore be decreased.

While in charge of the improvement of the channels connecting the Great Laes, and perfectly willing to assume responsibility for my actions, I am not in the habit of replying to adverse comments of this character, but the eloquence of the professor has inspired certain editors of the daily press to exceedingly wild and unjust attacks on other officers of the Corps of Engineers, and I therefore consider it proper to briefly call attention to a few of the most glaring engineering errors the professor has committed in the paper.

The improvement of the channel connecting the Great Lakes has consisted in:

(1) The construction of locks at Sault Ste. Marie to enable vessels to pass the falls at that locality.

(2) The deepening of St. Marys River.

(3) Dredging in the southern end of Lake Huron.

(4) The construction of the St. Clair Flats Canal, at the outlet of St. Clair River into Lake St. Clair.

(5) The dredging of a channel across Lake St. Clair.

(6) The deepening of the lower end of the Detroit River, and extending the channel into Lake Erie.

I invite attention to the fact that the St. Marys River connects Lake Superior with Lake Huron, and its deepening below the St. Marys Falls can have had no effect whatever on the total flow reaching Lake Michigan and consequently no effect on the elevations of Lakes Michigan and Huron. While the professor may be aware that such is the case, his inspired editors are not.

The dredging in the southern end of Lake Huron was in the open lake at points where there is no slope, and therefore could produce no effect on water levels.

In reference to Lake St. Clair, Prof. Williams has stated in a paper read before the American Society of Civil Engineers (*Transactions*, Vol. XLII, p. 165), that its current is very slow. The fall from one gage in St. Clair Flats Canal to the entrance to Detroit River is but 0.25 ft. in a distance of 18 miles. A channel across a body of water several miles wide, increasing its depth from 2 to 3 ft. only within a narrow channel could not diminish the level of another lake 40 miles distant.

It is therefore evident that the only work done by the United States that could possibly reduce the level of Lake Michigan 1 ft. is the deepening of the channel at the lower end of the Detroit River. The channel distance from the outlet of Lake Huron, at Fort Gratiot Light, to Amherstburg, is 82½ miles, and if the professor will intelligently use his computing ruler he will find that to lower the water at the upper end of a channel of that length 1 ft., will require a reduction in level at the lower end of at least 3 ft.

These are figures which do not require any careful study of complex gage relations to determine. A simple reading of the gages before and after the improvement is much better evidence. In 1898 the Deep Waterways Commission determined the difference in elevation of the water surface at Mamajuda Light House and Amherstburg (7½ miles apart) and found it to be 1.28 ft. A similar comparison in 1910 by this office gives 1.25 ft.

The professor claims that the reduction of levels in Lake Michigan to the extent of 0.58 ft. occurred, however, between 1890 and 1895, due to work performed from 1888 to 1891. The first project for a channel 300 ft. wide was practically completed in 1886. From 1886 to 1899 work was confined to a channel 400 ft. wide, and since that date the channel has been enlarged to 600 ft. The depths will have been progressively increased from 12 to 21 ft. at extreme low water when our work is completed. The expenditures on the Detroit River prior to 1888 were about $550,000; 1888 to 1891, $130,000; 1891 to 1898, $90,000; and since that date over $10,000,000.

The claim that from 1907 to 1910 there has been a still further reduction of 0.22 ft. in the levels of Lake Michigan is still more interesting. It is true that during these years a channel has been excavated 23 ft. deep and 450 ft. wide through the crest of the Lime Kiln Dam, but the work is at present surrounded by one of the largest coffer-dams that has ever been constructed, and no water has flowed through it. A board, of which I was a member, estimated that when *the dam is cut* the water may be lowered 6 in. just above it, and about 0.2 ft. in Lake Huron; it is therefore recommended that a dam be constructed from the channel to Bois Blanc Island to compensate for this loss of head. The matter is now being considered by an international tribunal.

A little knowledge is a dangerous thing and gage relations are also dangerous playthings for college professors. The scholastic mind does not appear to grasp the influence of Niagara River and Falls on the regimen of the Great Lakes. In the office of the Lake Survey this matter has been carefully studied, and it has been found that a rise or fall of 1 ft. in Lakes Michigan-Huron tends to produce a change of about 0.7 ft. in Lake Erie, but this change is also affected by the relative amount of rainfall over the two lakes, the amount of ice in the connecting rivers, and the direction of the prevailing winds, so that the mean of observations for a single month may give a difference of level between the lakes widely different from the average of a year, and if the professor will again apply his computing ruler he will find that the above law will reduce the discrepancies he has discovered between Lake Michigan and Lake Erie from 1 ft. to between 0.1 and 0.2 ft.

From the mass of mathematics relating to the subject which will be found in the reports of the Chief of Engineers, U. S. Army, for 1902 and 1904, Assistant Engineer L. C. Sabin has deduced the following formula for determining the fall in the Detroit River:

$$x = 3.03 + 0.41\ (H - 579) - 0.55\ (E - 571)$$

in which

x = the fall,
H = the elevation of Lake Huron,
E = the elevation of Lake Erie.

Applying this formula to summer elevations (to avoid ice effects) it will be found that instead of Lake Huron being lowered 0.22 ft., the level of Lake St. Clair has been raised about 0.3 ft. by the construction of the coffer-dam in the lower Detroit River, and that prior to the construction of this dam there had been no change in the gage relations of the lakes since 1872.

C. McD. Townsend.
Colonel, Corps of Engineers, U. S. A.
Detroit, Mich., Feb. 5, 1912.

Sir—Your issue of Dec. 14, 1911, contains an article headed "The Uses of the Great Lakes," in which are a few statements that should not go unchallenged, particularly since a partisan press has seen fit to make capital of erroneous and misguiding conclusions drawn therefrom.

Mr. Williams has deduced, through a peculiar course of reasoning, the theory that Lakes Michigan and Huron have been lowered about 8 in. by improvements in the outflow rivers, and that the federal government has been guilty of "robbing Peter to pay Paul" by thus increasing the amount of dredging necessary to provide equivalent harbor depths in the aforesaid lakes. The sting of criticism is later salved, however, by the claim that the lowering of the lakes is of more value to the riparian owners than the cost of reproducing the former depths for navigation.

It is difficult to understand the basis for the conclusion that riparian owners along the lake shores are benefited by lower lake stages. Surely the privately constructed canals, docks, slips and harbors would suffer millions of dollars damage by decreased depths; and even the property appurtenant to summer resorts and cottages would experience incalculable damage, as is evident from the bulk and character of complaints and inquiries that are being made regarding the recent decline in lake levels. The offsetting benefit then must accrue to unimproved frontages if the balance is to fall upon the credit side.

Along practically the entire lake shores, outside of the harbors, there runs at or near the water line a sharply declining or abrupt bank. The beach, if any, is low and flat and the lake bottom usually slopes gradually downward from the shore. If a 4-ft. lowering of lake levels would unwater a strip 100 ft. in width, as Mr. Williams claims, there would result an additional 100 ft. of beach which would be washed by waves in summer and packed with ice in winter. This exposed beach could not be cultivated nor occupied without extremely expensive protecting works, and in its natural state could serve only to remove the habitable land further from the waters to which its riparian value is due; and, without a single offsetting advantage, the recession of the waters would add greatly to the cost of docks or similar improvements which might be desired later. In some cases, bathing facilities might be benefited, and perhaps the "paramount use of the waters for sanitary purposes" may be the basis of the exaggerated valuation of this otherwise worthless beach. No one familiar with conditions could conceive of other benefits.

Regarding the decrease in recent years of the fall from Lake Huron to Lake Erie, it may be stated, first, that it is a demonstrable fact that there has been

less water flowing from the Great Lakes to the sea since 1890 than during the thirty years previous. It must appear reasonable to a layman that, generally speaking, the less water flowing through any stable channel the less will be the slope, and the less will be the difference in the surface level (or fall) between any two points. When the volume of flow is restored, the levels at these two points will be reëstablished and there will again be the same difference in level or fall. In case of any serious disturbance in the capacity of the channel the surface levels at the two points would lose their relative elevations and the fall would be changed for an equivalent flow.

To analyze the change, if any, of the fall from Lake Huron to Lake Erie during the period of authentic records, there are plotted, as Fig. 1, with Lake Huron stages for ordinates and Lake Erie stages for abscissas, five-year means from 1860 to 1909 of the summer stages (six months means each) for these two lakes. That the relation of surface levels has suffered no violent change is evident from the trend of the last three groups toward those of former years, and from the near approach of the 1905-9 group toward that of 1865-9. Also by grouping the five years previous to 1875 in which Lake Huron was at its lowest stages and the five years subsequent to 1895 when it was at its highest stages, it is found that these groups average the same level for Lake Huron and the average levels for Lake Erie differ by only 0.02 ft. In other words, the same fall is reëstablished for the same stages of Lake Huron. These points plot in the square on Fig. 1.

It being recognized that Lake Huron stages are abnormal in the early season due to ice jams in the St. Clair River, Fig. 2 is constructed similarly to Fig. 1, but with the summer crest on Lake Huron (usually July or August) for ordinates and with Lake Erie levels in December for abscissas. The interval of time is about that necessary for the effect of Lake Huron crests to reach Lake Erie.

From these diagrams it is evident that no change of 8 in. has occurred in the relative levels of these two lakes and that in fact the change, if any, is too small to be appreciable. It is true that the channels at Limekiln Crossing and at St. Clair Flats have received increased cross-sections by government improvements, but the increased efficiency of the channel, so far as discharge is concerned, is practically offset by encroaching dock lines along the two rivers, by the construction of Belle Isle Bridge piers in the Detroit River, and by shoaling in certain portions of the channel. Furthermore, it seems probable that the effects of the dredged channels on river and lake levels have been otherwise exaggeratd. Observations have demonstrated that the coffer-dam constructed around the dry cut of the Livingstone Channel, which has temporarily cut off more than three times the cross-section that was added to the river by the dredging of the Limekiln Channel, is creating a backwater effect on Lake Huron of only about 1½ in. The lowering effect of the Limekiln Crossing improvement is unquestionably less. The effects from other government improvements would be relatively smaller than that of the Limekiln Channel, and all are apparently compensated for by other changes. If this were not the case, the effect would surely appear in the comparison of lake levels shown in Figs. 1 and 2. ust as assuredly will the water levels on Lakes Huron and Erie return to their former elevations and the fall between these lakes be restored if the volume of flow again becomes what it was in former years. This is substantially proved by the accompanying diagrams, whereby it appears that the upward trend of the levels from 1895 to 1909 would be continued and the points representing the increased stages would fall among those of earlier periods.

Mr. Williams' argument beclouds the effect on lake levels of the Chicago Drainage Canal diversions, by attempting to show that while the lakes are not lowered thereby, that if they were, the effect would be generally beneficial. The ned of bolstering up the merits of Chicago's demand for additional water for sanitary purposes, and of apologizing for a use of these waters which is generally conceded consideration above all other uses, by such illogical argument is not apparent.

It cannot be successfully denied that the lake levels below Lake Superior have suffered from diversions through the Chicago Drainage Canal, and will suffer more by increased diversions. Lake interests have been greatly damaged through decreased depths in natural waterways and in improved channels and harbors. The government will be put to large expenditures to restore conditions in these improved channels and harbors that would now exist if the surplus waters of the lakes had continues to follow their natural course to the sea. This damage is not irreparable, however, as it is perfectly feasible to compensate for the lowering effect of the diversions by artificial obstructions in the outflow rivers which would not interfere with navigation, and the cost of these would be small compared with the original cos or the benefit to Chicago of the Drainage Canal. The sooner interested parties are advised that this damage is real, and that the remedy is simple and comparatively inexpensive, the sooner will the affected interests get together and work out the solution to their mutual benefit.

In the article in question, incidental reference is made to the rights of communities along the lakes to the benefits of the water for power development. It is no secret that a power-development scheme is intimately connected with the demand by the Chicago Sanitary District for permission to divert additional water from Lake Michigan; and the people behind the power company are apparently the most interested in protecting Chicago from any lack of water for sanitary purposes.

It is quite generally conceded that sanitary and domestic uses of water are paramount to all other uses. However, the right of Chicago, the State of Illinois, or any other particular section of the country to the unrestricted use of water, beyond that absolutely required for the protection of its people's health, cannot be established if damage to other communities and to other interests is incurred thereby. Moreover, any diversion of water at Chicago, considered from a standpoint of economics, not only results in damage to government improvements, to vessel and shipping interests and to riparian property owners below Lake Superior, but must be charged with further loss by virtue of the fact that for every horsepower developed from such diversion from 2½ to 4 hp. could be developed with the same water along the Niagara River, to say nothing of the further possible development on the St. Lawrence River. The only merit in an argument for the diversion of water at Chicago purely for power purposes must be based on the claim that the water of the Great Lakes is a local rather than a national resource.

F. G. RAY.

Detroit, Mich, Jan. 29, 1912.

Sir—Referring to the communications relative to "The Uses of the Great Lakes," from Col. C. McD Townsend and Mr. F. G. Ray, the writer wishes first of all to disclaim any desire to reflect in any way upon the United States Engineer Corps or any of its subordinates. However unfortunate the Navigation Laws may be they are not of the Engineering Corps' making, and the members of the Corps are to be commended for the loyalty with which they carry out their instructions and the support they give to decrees with which they oftentimes have little sympathy. Within that Corps and among its subordinates are many, including those named above, for whom the writer feels both professional admiration and warm personal friendship.

So far as the issues raised are concerned they are questions of fact. The mean elevation of the Great Lakes, as reported by the U. S. Lake Survey Office. show that for the past twenty years the mean elevation of Lake Michigan-Huron has been 1.43 ft. lower for the full year and 1.40 ft. lower for the open season than the mean of the preceding thirty years, and Lake Erie similarly has been

0.82 ft. lower for the full year and 0.81 ft. lower for the open season. Lake Michigan-Huron has therefore lowered about 0.6 ft. more than Lake Erie.

That the ratio of 0.82 to 1.43 happens to be about 0.70 does not explain why it is so, and any diversion from Lake Michigan at Chicago is also a diversion from Erie and Ontario.

Since 1879, at which time the work on the Lime Kiln Channel was begun, there has been removed from the waters connecting Lakes Huron and Erie, in carrying on channel improvements, material amounting to 24,586,899 cu.yd., which would make a channel 9 ft. deep, 300 ft. wide and 46 miles long. This material has been removed from the shallow places in the channels, including over a million cubic yards from the bar which formerly obstructed the discharge of Lake Huron into the St. Clair River. Every farmer, let alone engineer, knows the effect on the water flooding his lands of continuously going up and down the drainage ditch and deepening the shallow places as they appear.

From 1899 to 1903 a series of discharge measurements were made on the St. Clair River by the U. S. Engineers, and in 1908-09-10 these measurements were repeated by them at the same point. For the same stages of Lakes Huron and St. Clair the latter series, as reported, shows an appreciably greater discharge than the former, which is exactly what one would expect in view of the foregoing facts, and the writer ventures to predict a further lowering of Lakes Michigan-Huron and St. Clair when the Livingstone channel is fully opened, notwithstanding the compensation now proposed.

GARDNER S. WILLIAMS.

Ann Arbor, Mich., Feb. 17, 1912.

Compensation of Ruling Grades for Curvature

Sir—In your issue of Oct. 26, referring to the grades on the Argentine Central Ry. (Colorado), is the statement that a 6% grade on a 40° curve (143-ft. radius) is equivalent to 8% on tangent. Assuming 0.04% compensation, the equivalent grade would not be more than 7.6%, and it is entirely probable that for curves as sharp as this, even on standard gage, 0.03% is ample compensation, making the equivalent grade 7.2%. It is stated, in the same article, that the grade on a 20° curve on this road is 6.6% which, assuming 0.03% compensation, would make this also equivalent to 7.2%. So that it may be that, in spite of the conditions under which the road was built, some unknown transitman, whose name is probably forever lost, spent a few hours at night and used a little horse sense in fixing the grade line.

It is entirely probable (Wellington, p. 305) that the curve resistance on narrow gage is less than on standard gage. Therefore, for these sharp curves on 3-ft. gage even less than 0.03% per degree may be sufficient. I believe it is quite common practice with American engineers to use the same compensation (where any at all is used) on narrow-gage roads as on standard-gage. But where, as is often the case, these roads are built in mountainous countries with long stretches of line on ruling grades, excessive compensation may cost quite a little money. Personally, I should hesitate to recommend a lower rate of compensation without some further investigation, but some of your readers may know of (or be in a position to get) some reliable data of actual tests on narrow-gage lines which would be of interest and value if published.

In this connection also it may be noted that the statement is made in the same article that on the Wolgan Valley Ry., a standard-gage railway in Australia built presumably according to English practice, the combined curve and grade resistance on 4% grades with curves of 330-ft. radius (17.5°) is considered equivalent to 4.4% on tangent, indicating a compensation of about 0.023 per degree.

There was some discussion of this matter of compensation in your issues of April 16 and June 11, 1908, and since then C. S. Bissell, M. Am. Soc. C. E., has proposed (*Trans.*, Vol. LXVI, p. 59) the formula (for standard gage) $C = \frac{D}{D+18}$ where C is the percentage of reduction and D is the degree of curve. This formula, it will be noted, gives about 0.028 per degree for a 17.5° curve.

While the theory that the resistance due to curvature does not increase proportionately with the degree of curve is generally accepted, mention was made of a notable exception in your issue of Aug. 11, 1910, the compensation used on the Des Chutes Ry. (in Oregon), built according to the standards of the so called "Harriman" lines being given as: 0.035% for curves up to 6°, 0.045% up to 8½° and 0.050% up to 10°.

F. LAVIS.

50 Church St., New York, N. Y.

Notes and Queries

A correspondent in Montana asks for data on the problem of protecting 2000 ft. of earth embankment for a reservoir against wave action, by the use of piling and log booms. Suggestions from engineers experienced in this kind of work would be welcome.

A Popular Engineering Poem—The reprint of a poem entitled "Staking Out," in our issue of Jan. 25, seems to have brought simultaneously to the recollection of several correspondents another poem entitled "The Engineer," which has attained a well deserved popularity. As we have received copies of this poem with requests that we print it, from as widely separated localities as Narrows, Ore., Salt Lake City, Utah, and Waterbury, Conn., it is evidently well known to engineers. The first verse reads:

Who comes with Faber sharpened keen,
With profile long and sober mien,
With transit, level, book and tape,
With glittering axe to swat the stake?
The Engineer.

None of the correspondents above referred to knew the origin of the poem, and as it has been reprinted in numerous publications without reference to its origin or author, it seems worth while to give a few facts concerning it. So far as we can learn, it was first published in Engineering News of Dec. 30, 1897, p. 432. We received it in a little blueprint pamphlet sent by Chester T. Dike, City Engineer of Mason City, Iowa, to whom acknowledgement was made. Later we received a letter from W. J. McGinty, Secretary of the Ferguson Contracting Co., of Detroit, Mich., which was published in our issue of Jan. 20, 1898, p. 42. In this letter Mr. McGinty stated that the poem was written by him in May, 1897, at Corning, N. Y., where his company was the contractor for dike work on the Chemung River to protect the town of Corning from floods. The work was done under direction of Palmer C. Ricketts, Director of Rensselaer Polytechnic Institute as Chief Engineer, and Mr. McGinty records in his letter that it was the work of Director Ricketts and his assistant which inspired the poem.

Refuse Disposal at Cambridge, Mass., was reported on in 1911 by a special commission, appointed some time before to submit comprehensive plans for street developments and improvements for and disposal of refuse. The Commission included in its membership Lewis M. Hastings, city engineer; Edward W. Quinn, superintendent of streets; Harrison P. Eddy, consulting engineer, of Boston, and George M. Clukas, of Cambridge, the latter having been appointed to represent the citizenship at large, and Mr. Eddy having been selected to represent the Cambridge Taxpayer's Association. As to garbage disposal, no change is recommended. The present system is said to be in many respects entirely satisfactory, and any radical change would involve not only a large expenditure of money, but also a revenue loss of some $10,000 a year.

Most of the garbage, after having been collected by the city, is sold to outside farmers, who cart it away. The work is in charge of the overseers of the Poor Department of the city. Paper and other combustible refuse are now mixed to a greater or lesser extent with ashes and other incombustible material. Portions of the paper and other combustible material are now burned at the incinerator and the rest burned in the open air at various dumps. The open-air burning gives rise to numerous objections. The dumps are not only inconvenient, but are being rapidly filled up. Other incinerating plants are recommended, together with separation of the two classes of refuse and the burning of all the material which is not saleable. As to the other three classes of refuse, (1) ashes and other incombustible material, (2) street scrapings and sweepings, (3) material from street basins, it is recommended that the right be secured to use a number of abandoned clay pits in the extreme western parts of the city, in order to bring them to the original grade.

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Engineering News

A Heavy Damage Award for Failure to Securely Fence a Railway Line

One of the largest awards for personal injuries ever recorded has just been affirmed by the U. S. Circuit Court of Appeals in New York. Under this award the New York, New Haven & Hartford R.R. Co. will be obliged to pay the sum of $31,000 to a seven-year-old boy in Bridgeport, Conn., who was struck by a freight train while crossing the company's tracks and was so injured that both legs required amputation.

The accident occurred not at a public street crossing the tracks at grade, but at a point where an unauthorized passageway existed across the railway. The four-track line of the railway runs through the streets of Bridgeport at grade and is fenced off from the streets parallel with it by a wire fence on each side. At a point opposite two cross-streets, however, there were openings in this fence on both sides of the track. These openings have existed for years and have habitually been used as a passageway by the public, by railway employees and by some 25 school children. It was shown that the habitual crossing of the railway at this point by the public and the existence of the openings in the fence was known to the railway officials and that this passageway had been in existence for years.

In its decision the Federal Court says that where by long acquiescence the public has been permitted to cross railway tracks at a given point, the railway company is in duty bound to give reasonable warning of the approach of its trains. In the accident which resulted in the present suit, the evidence showed that the victim crossed one track just after an eastbound passenger train had passed, and then stepped onto the second track on which trains also ordinarily move eastward, but was struck by a freight train running west on this track. The court also emphasized the fact that no warning was given of the approach of the freight train by sounding the bell or whistle.

The verdict with its accompanying opinion is of interest to all engineers in charge of railway maintenance-of-way. Under the rule laid down by the court, it is evident that it would be better to allow railway tracks to go entirely unfenced rather than build fences and permit gaps to exist in them.

It is also evident that the amount which railway companies can afford to pay to remove their tracks from city streets is much increased if such heavy damages for personal injuries are to be assessed.

Does the Punishment Fit the Crime?

Due publicity has been given in the newspapers to the recent dismissal of Charles G. Elliott, Chief of the Bureau of Drainage Investigation of the Department of Agriculture, and A. B. Morehouse, Office Engineer. The offense for which these engineers were dismissed was set forth as follows by George F. McCabe, Solicitor of the Department of Agriculture, in a published statement:

> Elliott and Morehouse were dismissed by the Secretary of Agriculture because they had certified and presented false accounts, knowing them to be false, on which the Government had paid out moneys. Not only did they know the accounts were false, but they procured the persons to make the false accounts, telling these persons that they would receive money for their trouble. They admit they did this; they concealed their unlawful acts from their chief, Dr. A. G. True, and when Dr. True discovered the facts he recommended their dismissal.

It seemed to us this matter was worth a little further attention, as Messrs. Elliott and Morehouse have hitherto borne a good reputation for honesty, so far as we are aware. We therefore obtained from Solicitor McCabe's office a fuller statement of the facts regarding the offense for which these two engineers were dismissed. From this statement we present a summary as follows:

In June, 1909, nearly three years ago, the Bureau of Drainage Investigation found the appropriation for its current year's work slightly short of the amount necessary to complete the work in progress for the current month, which ended the fiscal year. The total amount needed for completion was small, in the neighborhood of $500; but under the law it was not possible to make these expenditures and pay them from the 1910 appropriation, which became available on July 1.

In order that the work in hand might continue without interruption, therefore, it was arranged that certain citizens who were interested in the work should advance the money from their own funds to meet the June pay-rolls and should be afterward repaid from the 1910 appropriation by receiving temporary appointments lasting between one and two months, the term being made just sufficient to reimburse these citizens for the money advanced and no service being rendered.

This arrangement was carried out, with the result that the United States lost not one penny by the transaction, but was the gainer in that its work was prosecuted continuously without interruption. This was, in fact, the sole object of carrying out this arrangement and not one of the parties concerned benefited personally by

the transaction in any way. The sole injury to the United States was that a few hundred dollars' worth of work done was paid for from the appropriation made for 1910 instead of from the appropriation for 1909.

It may be added further that Messrs. Elliott and Morehouse claim that they submitted the proposed arrangement to the Accountant of the department before undertaking it and received his approval, and state that they had no knowledge that the transaction which they undertook and carried out was in any way illegal.

In the above statement we have merely recited facts, as Mr. McCabe also recited facts in his statement which we have quoted above; but unless we are mistaken the two statements leave a very different impression upon the minds of the reader.

We are informed further that Mr. McCabe (the same McCabe who was instrumental in bringing the famous charges against Dr. Wiley discussed in our issue of July 20 last) "has followed up his action in causing the dismissal of Messrs. Elliott and Morehouse by referring the whole matter to the Attorney-General for submission to the U. S. Attorney of the District of Columbia, or for such other action as he may deem proper. The offense charged is a violation of Section 35 of the Penal Code, the statutory penalty for which is a fine of not more than $5000 or imprisonment for not more than five years, or both."

As we read this ponderous recital of Solicitor McCabe there comes forcibly to mind the song of "Pooh Bah" in Gilbert and Sullivan's opera, "The Mikado":

> My object all sublime
> I shall achieve in time,
> To make the punishment fit the crime,
> The punishment fit the crime.

However it may appear to Mr. McCabe, we do not think that to the engineering profession in general it will appear that the punishment meted out to Messrs. Elliott and Morehouse in any way fits their crime.

It is a foundation principle in the administration of justice that not only an act itself, but the motives which led to the act and the results of the act are to be taken into consideration in arriving at a just judgment.

According to the facts above recited, Messrs. Elliott and Morehouse have violated a department rule concerning the keeping of the accounts of government expenditures, which rule has in the wisdom(?) of Congress been given the dignity of a statute.

How many times does Mr. McCabe suppose that this departmental rule, or statute, and a dozen or twenty others of equal importance or unimportance have been and are being violated through one subterfuge or another by engineers and *by lawyers* engaged in government service who find such violations essential to secure efficiency and economy in carrying out the government's work. Let Messrs. Elliott and Morehouse be punished by all means, but let their punishment fit their crime.

As we read over the above statement by Mr. McCabe, however, we seem to discern evidence that another crime has been committed. The familiar quotation runs: "He who steals my purse, steals trash, but he who steals my good name, steals that which does not enrich him but makes me poor indeed."

Did Solicitor McCabe couch the statement we have quoted above in such terms as would work least or greatest injury to the engineers affected? Are there reasons not apparent on the surface why he was desirous of magnifying the alleged crime and making the punishment therefor, direct and indirect, as severe as possible? If the scales of justice were evenly balanced, would they not show an attempt to blacken a man's reputation to far outweigh in criminal obliquity even the infringement of a statute enacted to compel accuracy in government accounting?

And there is another class of questions which should be asked: Does Mr. McCabe think that efficiency in the government service is promoted by such action as that which he has caused to be taken in the case of these engineers? Are engineers of high standing encouraged to enter the government service and use zealous endeavors to promote efficiency in its work when they see minor infractions of regulations punished with such severity? Does Mr. McCabe know any well conducted private corporation which has adopted such methods to build up a loyal and efficient staff? Our readers can make their own answers to these questions from the facts which we have recited above.

There is, however, one additional question which it seems to us deserves some thoughtful consideration by engineers:

When an engineer is unjustly assailed, and especially when the attack involves, to a greater or less extent, the general reputation of the profession as well as his own, has the profession at large any responsibility in the matter? Is there any way in which the organizations that engineers have formed for mutual benefit can be made use of for mutual defense? If the engineering societies can act to expel the member who has been proven dishonorable and unworthy, why can they not also act to defend their member whose reputation is unjustly attacked?

Large Rock Crushers

Since crushed rock has come into such extensive use for concrete making and other purposes there has been a great increase in the number and size of rock-crushing plants, and accompanying this has come many improvements in the design of such plants. Probably no one thing has contributed so much to increase the efficiency of large crushing plants as the building of rock crushers of sufficient size to take in large chunks of rock as they come from the quarry.

With a crusher able to take in a piece of rock larger than a good sized office desk, the rock in the quarry can be broken down by heavy shots and loaded by steam shovels, and it is very seldom necessary to stop work in order to fire mud shots on a piece of rock too big for the crusher.

Looking back through the files of ENGINEERING NEWS, we find in 1898 what was then called an "enormous" rock-crushing plant with an unprecedented output of 200 tons per hour. For this plant the primary crusher was a gyratory machine having a mouth opening of 18x42 in. and weighing 90,000 lb. Twelve years later the largest crusher of this type in use in a similar works had a mouth opening of 48x120 in., weighed 500,000 lb. and produced 700 tons of 7-in. crushed rock every hour. Although we have not the figures available, it is doubtless true that the later plant effected an enormous saving in the cost of the finished stone, at the same time producing the crushed material at a minimum of labor and a maximum of automatic operation.

Such an increase is typical of what has taken place in stone-crushing machinery. It is notable, however, that until recently this great increase in the size of crushers has been true only of the gyratory type, which by reason of its construction and the massiveness of its parts lent itself well to such an increase in size.

Some years ago Thomas A. Edison, improving the fundamental idea of a crusher roll, produced his now well

FOUR LARGE ROCK CRUSHERS OF DIFFERENT TYPES

Location	Kind of crusher	Capac. of crusher, tons per hour	Size of opening, inches	Size of exit in.	Max. wgt. of stone taken, tons	Weight of crusher	Reference in "Engineering News"
Tomkins Cove, N. Y.	Edison roll	3000*	120x120	7	20	330	Jan. 12, 1911, p. 29
Doles & Shepard, Chicago, Ill.	McCully gyratory	1000*	42x96	6	10	212	Oct. 21, 1909, p. 421
Biwabik Co., Biwabik, Minn.	Gates gyratory	700	48x120	7	10	250	Nov. 24, 1910, p. 876
Kensico Dam	Blake jaw	700	60x84	9	10	225	Feb. 22, 1912, p. 335

*The capacity of the plant is lower than this on account of the lower capacities of the smaller crushers. The first crusher is therefore in use only a portion of the time.

known knobbed rolls which by gradual steps have been brought to a greater capacity, both in output and size of opening, than any other crusher of any type. The giant rolls at the Tomkins Cove plant on the Hudson River are, we believe, the largest stone crushers in existence. In this issue, however, appears a description of a huge stone crusher of the Blake or jaw type, which is of a size quite comparable with the largest gyratory machines. This type of stone crusher antedates the gyratory machine and has held its own for use in small plants and as a portable machine, while its rival has taken the lead for plants of large capacity. From the article in this issue, it would appear that this leadership is not to be uncontested.

We have no figures as to the comparative cost of construction and operation of the various types of large crushers; but that in size, at least, there is but a slight difference in the possibilities of each type, is shown by the accompanying table of four large crushers, which, so far as we have been able to discover, mark the record constructions in their respective types.

The remarkable feature of the last noted machine, the Blake jaw crusher for the Kensico dam, is that it is a part of a construction plant, which is to be in service for perhaps no longer than two or three years. All of the other large crushers noted are the primary units in permanent plants producing crushed stone for the trade. It may be remarked, however, that the very massiveness of the Kensico plant makes its salvage value very high; and the probability is that after the completion of its work furnishing crushed rock for the building of the great dam, it will be installed in some plant producing crushed stone for sale.

A Worthy Civic Center for New York

The new terminal building at the Manhattan end of the Brooklyn Bridge, shown on the first page of this issue, the selection of a site for a new court house a little to the north of the terminal, the new Municipal Building between the two, and the nearness of all three to the City Hall and Hall of Records, combine to form a notable beginning for a civic center worthy of Greater New York.

It is to be hoped that the proposal to locate other public buildings adjacent to the new court house and to provide suitable open space around the group will be carried into effect by the Board of Estimate and Apportionment. It is also to be hoped that included in the group may be a new post office of ample capacity and of such architectural design as will harmonize with the other members of the group.

The erection of a new post-office building would free City Hall Park from the old federal building, which is not only an abominable piece of architecture but an encroachment on the Park. The erection of the new court house will make possible the removal of those other encroachments on the park area, the old Register's Office, now used for court purposes, and the Tweed Court House at the north end of the Park. As a monument of the worst era of municipal corruption New York has ever known, New York can spare the Tweed Court House without a pang of regret, and certainly the homely old Register's Office will be more admired for its absence than for its presence. With all the other buildings in the Park removed, New York's fine old City Hall would have a setting worthy of its merit as a choice example of the best American architecture of a century ago.

As the streets bordering on City Hall Park become more completely lined with twenty-story and fifty-story office buildings, the City Hall itself will be more and more prized, both as an architectural gem and as a memorial of the New York City of a century ago. At present the City Hall is crowded and partially dwarfed by the old court house, while from lower Broadway it is entirely obscured by the ugly pile of stone which forms the post office, and which is a monument to the worst period of our Federal architecture. The multi-storied office buildings surrounding City Hall Park are so much taller than the City Hall and so dissimilar in other respects as to make the City Hall a gainer rather than a loser from the very immensity of the contrast. While an idealist might wish for more space at the north of the City Hall and possibly less height and a different placing of the new Municipal Building, yet if the three other buildings in the Park are removed, there will be sufficient space around the City Hall, so that even the tallest of the tall buildings will neither dwarf nor overshadow that structure.

While those accustomed to the low buildings of other countries might object to the great height of the new Municipal Building, wherever placed, persons familiar with office conditions in downtown New York and aware of how the city departments are now scattered about in various rented quarters, can appreciate the need of a municipal office building having not only a large ground plan but also a towering height. The new Municipal Building, viewed in proximity to the City Hall, has a peculiar fitness as typifying the changed conditions in municipal office needs during a single century of city growth.

Although the new Municipal Building, as shown by our front-page engraving, looks somewhat as if it had been mistakenly placed too far to the north (or left) by half its length, and while there might have been some gain in symmetry and possibly in utility and general fitness by centering the east and west axis of the building on the central axis of the bridge, there were certainly strong utilitarian and esthetic reasons for placing it exactly where it is. On the utilitarian side, the three great streams of traffic (bridge, elevated and bridge-loop subway) are better separated, while, on the esthetic side, if the municipal building had been combined with the bridge-terminal station, it would have virtually obliterated the latter, and would have been brought more directly than now into unfavorable contrast with the City Hall. Obviously, the only logical position for the Municipal Building, if it were sought to make it a direct contrast with the City Hall, would have been directly back of that structure (on the north side of Chambers St.). Had this been done, and done early enough, the Municipal Building might then have occupied the whole block between Broadway and Centre St. Placing the Hall of Records on the Centre St. corner made this impossible, but left it temporarily possible to put a municipal building in the center of this block, with either a wing or a separate public building on the Broadway corner. (The central site is now occupied by a tall modern building, the Emigrant Industrial Savings Bank.) A municipal building symmetrically placed back of the City Hall would certainly have given a fine opportunity for an appropriate contrast between the old and the new public buildings, but if the Broadway and Chambers St. corner is soon worthily built upon, so as either to balance or to fittingly contrast with the Hall of Records, perhaps there need be no regret that the Municipal Building was not placed back of and thus in direct contrast with the City Hall.

Since the occasion for these remarks is the new building for the Manhattan terminal of the Brooklyn Bridge, it seems desirable to discuss here one phase of the design of monumental bridges within a city.

We doubt whether any other great bridge of the world has ever been so degraded at both terminals as has the Brooklyn Bridge. Always without the worthy approaches which so noble a structure deserved, the Brooklyn Bridge has also been disfigured at either end for the thirty years since its completion by the most baldly utilitarian structures imaginable. With its new York or Manhattan terminal close to the fine old City Hall and with the Brooklyn terminal readily prolonged to a site near the Brooklyn municipal buildings, there was afforded to the authorities of the two former cities, and later to those of Greater New York, an almost unprecedented opportunity for a dignified, artistic treatment of each bridge terminal,

worthy of the metropolis of the new world. Instead, first commonplace minor structures were built at either end of the bridge and later on ugly train sheds were erected over blocks of space at the Brooklyn end, and a hideous contraption of structural steel was built over Park Row, terminating in a most ordinary stairway at one side of City Hall Park in Manhattan.

We are aware that the unfortunate disfigurements which have been perpetrated upon the original commonplace terminals at either end of the Brooklyn Bridge have been in large part due to the unforeseen growth of traffic. This marvelous increase in the use of the bridge so taxed the capabilities of those charged with caring for it that they were unable to give to the users of the bridge even the ordinary comforts and decencies of travel. Under such circumstances it is no wonder that all thoughts of civic fitness or architectural excellence were completely ignored.

The difficulties of the terminal problems at either end of the Brooklyn Bridge have been multiplied by the fact that the bridge and its approaches were originally designed to accommodate only foot and vehicle traffic and the shuttle trains of the cable railway across the bridge. Later, Brooklyn surface cars and elevated trains were brought across the bridge, and the terminal stations at either end were built, with the resulting eyesores which have come to be regarded as a accompaniment to the confusion, crowding and risk to life and limb of the morning and evening "bridge jams."

It is a pleasure to be able to depict as we do in the front-page engraving already mentioned, a great change for the better which is to be made at the Manhattan terminal. Just what could now be done at the Brooklyn end we will not attempt to discuss at the present time; but that something ought to be done to relieve Brooklyn of such a gross disfigurement as now exists, everyone with civic and esthetic feeling will agree. While the need for a removal of the disfigurement of the Manhattan terminal was more pressing, and therefore has properly come first, it should be followed as soon as possible by appropriate changes at the Brooklyn end of the bridge as well.

New Kingswood Tunnel, B. & O. R. R.

In double-tracking a portion of the Cumberland Division of the Baltimore & Ohio R. R., an old single-track tunnel through the Allegheny Mountains was one of the problems to be considered. As the eastbound traffic is much the heavier, it was decided to build a new double-track tunnel for this traffic and to leave the old tunnel to carry the lighter westbound traffic. The construction of this new tunnel is described in the accompanying article.

Among numerous improvement works now in progress on the Baltimore & Ohio R.R. is the revision of the line between Blaser and West End, W. Va. (on the Cumberland Division), for the purpose of relieving congestion at the present Kingswood tunnel, which has only a single track. This improvement consists of an additional double-track tunnel for eastbound movement, with reduction of curvature and eastbound-grade reduction. This will provide increased facilities to take care of the heavy traffic in this locality, and will permit greater train loading and the use of Mallet helper engines. In accomplishing this result it was necessary to make an entire revision of line and sidings, etc., through the town of Tunnelton, W. Va.; also to change streets and roads, eliminate grade crossings, construct a new station, etc. The old tunnel will be used for westbound traffic. It is equipped with a ventilating plant in order to increase its traffic capacity. A plan of the improvement is shown in Fig. 1.

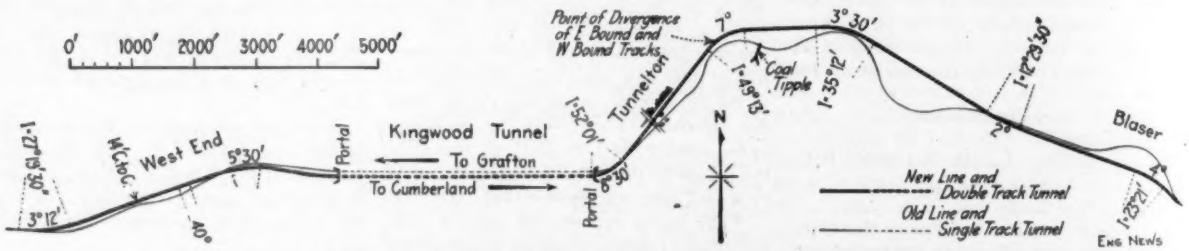

FIG. 1. PLAN OF LINE REVISION BETWEEN WEST END AND BLASER, W. VA., WITH OLD AND NEW TUNNELS; BALTIMORE & OHIO R.R.

The work is under the supervision of Francis Lee Stuart, chief engineer of the Baltimore & Ohio R.R., and J. T. Wilson, district engineer, with offices at Baltimore, Md. The resident engineer on the work is E. M. Graham, located at Tunnelton, W. Va. To these gentlemen we are indebted for plans and information concerning the work.

The general contractors are Bennett & Talbott, of Greensburg, Penn.; D. O. Bennett & Co. are subcontractors for the masonry and tunnel lining.

DESCRIPTION OF TUNNEL

The most important feature is the construction of the new tunnel, which pierces one of the lesser ridges of the Alleghenies, immediately west of the town of Tunnelton, in Preston County, W. Va. It is located 83 miles west of Cumberland, Md., and 18.4 miles east of Grafton, W. Va.

It is a double-track tunnel, 31 ft. in clear width and 24 ft. 6 in. clear height (above top of rail) at center of section. The springing line is 11 ft. above subgrade, the sidewalls are plumb, and the roof has a semicircular five-ring brick arch of 15 ft. 6 in. radius. The sidewalls are of concrete, with minimum thickness of 24 in. inside neat line. The foundations are not less than 12 in. below subgrade and 3 ft. wide. The dimensions and form of cross-section, etc., are shown in Fig. 2.

A space 31 in. high and 7 in. wide, immediately above the foundations, is left on each side for the future installation of wire and cable conduits. Refuge niches 4x6 ft. and 18 in. deep (resting on top of conduit opening) are placed 100 ft. apart on both sides, being staggered 50 ft. (Fig. 3). Cable or switch boxes 6 ft. high by 4 ft. wide and 20 in. deep, resting on the subgrade elevation, are placed 300 ft. apart on both sides.

The grade of the new tunnel is 0.4% ascending east; it connects at the west end by means of a long vertical curve with a 2.1% straight grade, and at the west end with a grade of 0.5% (compensated for curvature) ascending eastward for two miles to the summit at Blaser (Fig. 4). The new tunnel, at its east end, is approximately 24 ft. below the old one. Both tunnels are on tangent (except for spirals at the extreme

ends), and are parallel to each other, with their center lines 80 ft. apart. The new tunnel is 4211 ft. in length, compared with 4149 ft. for the old tunnel. The length was originally intended to be the same, but considerations of time to be saved in completing the tunnel led to increasing the length at the west end, and correspondingly reducing the approach cut.

The rock in tunnel and cuts is a dense gray shale, disintegrating rapidly on exposure to the air. In places the shale shaded into an impure limestone. A few thin streaks of sandstone were encountered in the east-end bench. In general the rock drilled and shot in a very satisfactory manner. There was but little water, and practically all of it came from the shafts.

Shafts and Approach Cuts

The drilling at the east-approach cut was done partly with a well-drilling rig on top of the cut. Ordinary tripod drills, operated by air, were used at the west-approach cut and in the bottom half of the east cut. The rock was loaded by steam shovels into narrow-gage dump cars. The west-approach cut involves 90,000 cu.yd. of excavation. Work began Sept. 26, 1910, and at the end of January was 94% completed. The east-approach cut involves 190,000 cu.yd. Work was begun Oct. 5, 1910, and is now 88% completed.

There are three shafts, located as shown in the profile, Fig. 4.

Shaft No. 1—This is located directly over the east portal and is 64 ft. deep to the bottom of the wall plate. Its size inside the lining is 8x12 ft. It was commenced on Sept. 16, 1910, and completed Oct. 20, 1910. Total days, 34; days worked, 29. Average rate of sinking, 2.21 ft. per day of 20 hr., for the 29 days worked. The plant consisted of a derrick and scale boards, the skip being dumped on a platform having a trap, beneath which the horse-operated dump cars were driven. The derrick was operated by a 15-hp. double-drum hoisting engine and a 5-hp. swinging engine, taking steam from a horizontal boiler.

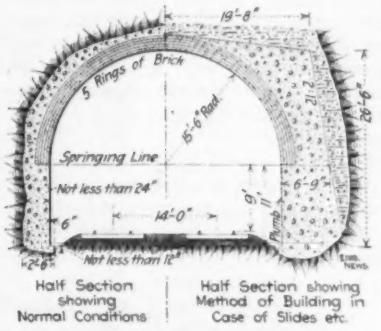

Fig. 2. Cross-section of New Kingswood Tunnel; B. & O. R.R.

Shaft No. 2—This is near the middle of the tunnel and is 170 ft. deep to bottom of wall plate. Its size inside the sheeting is 10x20 ft. It was commenced Sept. 20, 1910, and completed Dec. 2, 1910. Total days, 73; working days, 64. The rate of sinking was 2.66 ft. per day of 20 l.r. for the 64 days worked. The plant for sinking consisted of a derrick and steel buckets operated by a 15-hp. double-drum hoisting engine, taking steam from a horizontal boiler. Upon the completion of the shaft there was substituted for this plant a pair of cages, sliding in vertical guides, raised and lowered by steel cables passing over large pulleys at the top of a head tower. The cables were led to the 48-in. drum of a 50-hp. single-drum hoisting engine having two cylinders 10x12 in., and capable of a cable speed of 600 ft. per min.

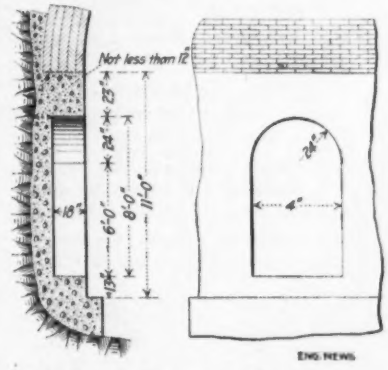

Fig. 3. Refuge in Tunnel

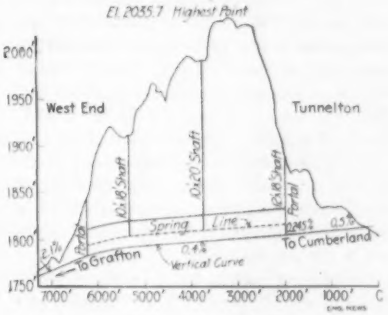

Fig. 4. Profile of New Kingswood Tunnel, B. & O. R.R.

Steam was supplied by the same horizontal boiler.

Shaft No. 3—This is located a short distance from the west portal, and is 106 ft. deep to the bottom of the wall plate. Its size inside the sheeting is 10x18 ft. It was commenced Oct. 11, 1910, and completed Nov. 20, 1910. Total days, 40; days worked, 36: Average rate of sinking, 2.94 ft. per day of 20 hr. for the 36 days worked. The sinking plant consisted of a derrick and buckets, operated by a 15-hp. double drum hoisting engine worked by compressed air. Upon the completion of the shaft there was substituted for this a pair of alternating cages, similar to those at shaft No. 2, with cable attached to the single drum of a 25-hp. hoisting engine, operated by air.

Headings

From the shafts and portals were driven top drifts or advance headings 8 ft. high and 12 ft. wide, the floor of the drift being at the level of the bottom of the wall plate or 6 ft. above the springing line of the arch. These were enlarged to the full size of 37 ft. 8 in. width at bottom of wall plate and 13 ft. high at center of arch, to accommodate the timbering under which the brick arch was to be built.

For each drift there was a gang of about 22 men with four drills, and 21 holes were drilled for each round. The gang was made up as follows: One foreman, 4 drill runners, 4 drill helpers, 2 nippers, 1 powderman, 1 driver, and 9 muckers. For widening the drift to the full section there were about 25 men

TABLE I. PROGRESS OF DRIFTS AND HEADINGS OF KINGSWOOD TUNNEL, B. & O. R. R.

Reference Letter	Headings	Actual Working Days	Distance, Ft.	Rate per 20-hour Day, Ft.
	(A) Progress in the advance 8x12-ft. drifts and in the advance timbered headings			
A	No. 1 west, drift 7x12 ft	17	42	2.47
B	No. 1 west heading*	95	362	3.81
C	No. 1 west, drift 8x12 ft	43	501	11.65
D	No. 2 east, heading	24	44	1.84
E	No. 2 east, drift 8x12 ft	75	805	10.73
F	No. 2 west, heading	24	38	1.58
G	No. 2 west, drift 8x12 ft	59	571	11.37
H	No. 3 east heading	42	74	1.76
I	No. 3 east drift, 8x12 ft	65	794	12.21
J	No. 3 west, heading	42	70	1.67
K	No. 3 west, drift 8x12 ft	40	484	12.10
L	West portal, drift 8x12 ft	11	58	5.27
M	West portal heading	64	262	4.09
	*Heading here means full-size timbered heading.			
	(B) Progress in completion of full-size timbered headings after 8x12-ft. advance drifts had been completed			
R	No. 1 west	52	384	7.38
S	No. 1 west	12	36	3.00
T	No. 1 west	26	141	5.42
U	No. 2 east	115	781	6.79
V	No. 2 west	116	752	6.48
W	No. 3 east	109	713	6.54
X	No. 3 west	39	289	7.41
Y	West portal, east	13	59	4.54
Z	West portal, east	26	195	7.50

with four drills; for each round there were six to eight holes drilled on each side. The gang was made up the same as for the drift work except that there was only one nipper (instead of two) and the muckers were increased to 13 (instead of 9). In both the drift work and the widening, the muck was loaded into narrow-gage dump cars hauled by mules to the shafts (to be hoisted out), or toward the end of the bench, to be rehandled by the shovel.

No. 1 heading was begun Oct. 20, 1910, and met No. 2 heading east on April 21, 1911, the latter having been begun Dec. 2, 1910. No. 2 heading (west) was begun Dec. 2, 1910, and met No. 3 heading (east) April 11, 1911, the latter having been started Nov. 22, 1910. No. 3 heading (west) was begun Nov. 22, 1910, and met west-end heading March 13, 1911, the latter having been begun Dec. 13, 1910. The progress in detail at the headings is given in Table I. The upper part of this shows the progress in the advance 8x12-ft. headings and in the advance timbered headings.

Combining headings B and M (but omitting D, F, H and J on account of short distance and slow progres in getting started), we have 3.92 ft. per day of 20 hr. as the average rate of progress for the full-size timber heading without any advance heading. Combining C, E, G, I and K (but omitting A and L for the reason stated above) we have 11.54 ft. per day of 20 hr. as the average rate of progress for the 8x12-ft. advance heading. The installation of cages at shaft No. 2 and No. 3 required 17 and 10 days, respectively.

Timbering was resumed and completed after the advance headings met, as shown in the lower part of Table I (at B). This gives the progress in the completion of full-size timbered headings after the 8x12-ft. advance headings had been completed.

Combining these (but excepting S and Y, where progress was unusually slow on account of the extra precautions taken in producing the timbering back to the portals), gives an average of 6.74 ft. per heading per day of 20 hr., or one set of 16-ft. wall plates every 2.37 days. Timbering was suspended for 18 days in No. 1 heading on account of digging out shaft No. 1.

Timbering

The timbering consists of two rows of 12x12-in. wall plates, approximately 16 ft. long, spaced 35 ft. 8 in. face to face and bedded 17 ft. above subgrade. These support, generally at intervals of 4 ft. (but sometimes closer, depending upon the character of the roof), seven segment rings of timber, 12 ft. in the clear at the center above the bottom of the wall plates. The rings are covered with 2-in. lagging, and the space between lagging and rock is packed with stone from the muck pile.

Ordinarily the advance 8x12-ft. heading was widened sufficiently on both sides to permit the placing of a pair of wall plates in proper position. When these were firmly wedged and blocked in position, the roof was shot down and the rings erected, sheeted and the space above packed, from temporary scaffolding supported on the muck pile. In bad ground separate drifts were driven for each wall plate, and the rings were excavated for and placed singly.

Bench

For the bench, the rock was blasted in the usual way and the muck removed by two 60-ton air-operated shovels, with standard booms. The progress was as shown in Table II. It should be noted, in this table, that the west-end shovel worked throughout 10 hr. of the 24, while the east-end shovel, for its first 20 working days, worked 20 hr. of the 24. As will be seen, the increased progress was in no way proportional to the increased expense, and for the remainder of the time single shift was adopted for this shovel also.

The dump cars were spotted singly for these shovels. A 16-hp. double-cylinder double-friction drum-hoisting engine, operated by air, both placed and removed the cars for the west shovel. For the east shovel, a smaller engine placed the cars, but did not remove them.

In shooting the bench, trenches (or "cat holes") were first sunk, at right angles to the line of the tunnel, at intervals of about 16 ft., and to a depth of 3 to 4 ft. below wall-plate grade, or sufficient to permit the handling of 16-ft. drills under the timbering. Four holes were then sunk in each of these trenches, the outer ones starting about 5 ft. from the wall plates, and slanting slightly away from the center of the tunnel. The remaining two holes were evenly spaced, and all extended down about 2 ft. below the finished subgrade. The outside holes were loaded with about 90 sticks each, and the inner holes with about 150 sticks each, and the four were exploded simultaneously.

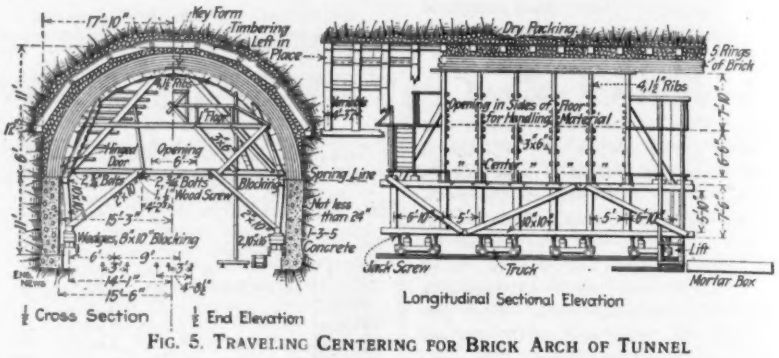

Fig. 5. Traveling Centering for Brick Arch of Tunnel

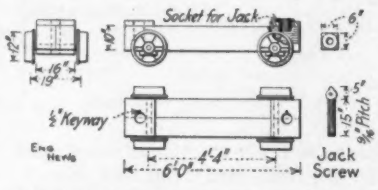

Fig. 6. Truck for Traveling Tunnel Centering, with Jack Screws for Adjusting Position

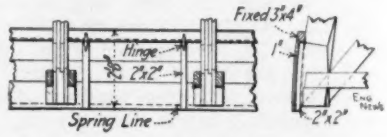

Fig. 7. Detail of Centering at Springing Line of Arch

TABLE II. PROGRESS OF POWER SHOVELS IN REMOVING BENTS

	West End Bench	East End Bench
Total days	193	86
Days worked	147	67
Distance, ft.	2781	1419
Rate for total days*	14.41	18.92
Rate for days worked*	16.50	21.18

*Rate in feet per day

Concrete Sidewalls

Construction of the concrete sidewalls began at the west portal July 26, 1911, and ended Sept. 29, 1911. At that time 1396 ft. of double wall had been poured, the shovel excavating the bench being in the way of further work from that end. This represents a progress of 43 ft. of single wall (running about 1 yd. per ft.) for the entire time, or 60.7 ft. for actual working time, per day of 10 hr.

On Nov. 7, 1911, work on the sidewalls was started at the east portal, and to Dec. 20, 1911, 1403 ft. of double wall had been poured, representing a progress of 53 ft. of single wall per 10-hr. day for the entire time, or 63.8 ft. for the actual working time. As much as 96 ft. and even 112 ft. of single wall have been poured on individual days. The walls are built mainly in lengths of 100 ft., each section being completed to its full height at one time. For 300 ft.

at each end, however, the walls are built in 50-ft. lengths.

The concrete plant at West End is on a siding near the portal and consists of a 1-yd. mixer, and a derrick with clam-shell bucket for unloading sand and gravel from the cars and for keeping the gravel bin full. Sand is raised to the mixing platform with a bucket conveyor. The concrete is a 1:3:5 mixture; both broken stone and gravel are used, but mainly the latter. The concrete is poured into bottom-discharge buckets, which are hauled into the tunnel by dinkeys or narrow-gage locomotives, and there raised to the top of the form by a traveling crane on standard-gage tracks. A similar plant is now in use at the east portal. The forms are of 2-in. plank, and are strongly braced against the opposite wall. They are built in permanent 16-ft. sections, which are used repeatedly.

Brick Lining

The construction of the brick arch was begun at the west portal Oct. 11, 1911, and to Dec. 30, 1911, 1461 ft. had been built. This is an average of 20.5 ft. per day for the entire time, or 25 ft. per 10-hr. day actually worked.

Two movable sets of centers are maintained, each carrying double-deck working platforms. These centers are kept several hundred feet apart, and are used on alternate days. Standard-gage gondola cars with brick and packing stone are run under these centers and unloaded on the lower working platform; the bricks are unloaded through an opening in the platform, and the stone over the end. Mortar is hoisted in buckets on a small elevator. One of these traveling centers is shown in Fig. 5, while Figs. 6 and 7 show the details of the supporting trucks and the arrangement of the form at the springing line. The trucks are of 19-in. gage. In the center of the tunnel is a three-rail track for standard gage and 3-ft. gage, and on each side of this is a track of 3-ft. gage.

The brick arch, of five rings of brick 4 in. thick is built underneath the original timbering, and the space between the arch and the timbering is filled with dry packing, obtained from a sandstone quarry opened for the purpose, directly over the portal of the tunnel. A 25-ft. section of arch, such as is built each working day, entails the placing (in arch and spandrels combined) of approximately 31,675 brick. These are handled by six bricklayers.

Power and Light

Compressed air for running the drills, pumps, hoisting engines and power shovels, inside the tunnel was supplied by four 125-hp. compressors. A small dynamo served for lighting the compressor plant, but electric lighting was not used at any time in the tunnel. Light was furnished in all the headings exclusively by gasoline torches and "banjo" lights. These were very smoky. Large carbide lights, in addition to the gasoline lights, were used for lighting the bench in front of the shovels.

Annual Meeting of the Indiana Sanitary and Water Supply Association

Reported by W. G. Ulrich*

The fifth annual meeting of the Indiana Sanitary and Water Supply Association was held at Indianapolis, Feb. 15 and 16. About 175 water works men, mayors and health officers were in attendance, representing 65 towns throughout Indiana and adjoining states.

Halford Erickson, member of the Railroad Commission of Wisconsin, read a paper on "The Public Utilities Commission." He gave at some length the various details of appraisal work in Wisconsin, and summed up as follows:

> It may be said that since the value of public utilities constitutes one of the principal elements that enter into the establishment of equitable relations as between the investors in such utilities on the one hand and the customers of the same or the public on the other it is of the greatest importance that this valuation should be placed at a figure that under the circumstances is equitable and fair to both sides.
>
> To obtain a valuation that will meet these requirements, however, through strict adherence in the appraisal to any single formula or method would seem to be almost impossible, owing to the number and the complexity of the conditions and facts which, to that end, must be taken into account. But through the employment of various methods that are adapted to the conditions and through careful consideration of the elements involved, it is possible to obtain figures which fairly represent the original cost and the cost of reproduction of both the physical plant and of the business as well as of such depreciation as has taken place in the property and of other conditions by which the value is effected. From these facts, when fully considered and properly used, it is undoubtedly possible to obtain a valuation that is fair and equitable to all concerned.

Dr. George B. Young, Commissioner of Health, City of Chicago, pointed out the economic value of good sanitation. As an example he said that typhoid fever incapacitates 450,000 persons in the United States for many weeks each year with a resulting loss of $150,000,000. He said that in the city of Buffalo alone the economic loss from tuberculosis is conservatively estimated at $2,557,000 per year. He added:

> Buffalo is doubtless a healthy city, but if we add the cost of the typhoid, the pneumonia, the influenza and other infectious and contagious diseases, the blindness and the like, all largely preventable, we should probably find the total not far from twenty millions of dollars—which is no light handicap in the way of unproductive consumption to the industrial productiveness of a city of 425,000 inhabitants; and this is not all by any means. The burden of supporting those incapacitated by preventable causes is no small addition to the load, but all these together are surpassed by the loss due to the lessened efficiency and curtailed productivity of the thousands unfavorably affected by insanitary conditions of residence and employment.

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Dr. W J McGee, soil-water expert, U. S. Bureau of Soils, in a paper on "The Diminishing Well Supply of Indiana," presented tables of statistics showing that the well supply of Indiana is decreasing each year.

Dr. Henry Jameson, Park Commissioner of Indianapolis, urged that the care and beautification of the stream banks of a city have a direct practical and financial value to the people. C. H. Worden, Park Commissioner of Fort Wayne, followed with a talk along much the same lines. He said one of the best things a city could do was to get posession of the river banks.

On the subject of "The Value to a Community of Safe Water," Chas. B. Burdick, of Chicago, showed that the cost to a city of erecting a filter plant was repaid from one to three times on account of the saving cost by the improvement in public health. In Cincinnati he said the cost of operating the filter plant was about one-tenth of the amount the city would have to spend under other circumstances on account of sickness.

In a paper entitled "Fire Waste and Fire Prevention," by Richard Lieber, of Indianapolis, it was suggested that courses in Fire Protection Engineering be taught in each of the State Universities.

In the course of an interesting paper on "The Effectiveness of Hose Streams in Fire Fighting," Howard Dill, of Richmond, Ind., said that the fire and water departments are mutually interested in fire protection. No matter how efficient one department may be its efforts may be nullified or lessened by the inefficiency of the other.

Prof. R. B. Wiley, of Purdue University, in a paper on the "Economy of Combined Water and Light Plants in Small Cities," said many small cities in the country are without water or light plants for one of two reasons. Either the people in the city are not progressive enough to recognize the importance of these things or they are deterred by the expense involved in the establishment of such plants. He presented tables designed to show that combined water and light plants could be managed at a profit in places of 1000 to 1500 population. In regard to the various methods of financing the plant he suggested a private corporation with the stock held locally in as small blocks as possible, thus creating a maximum of local interest in the works.

E. L. Loomis, Superintendent of the Valparaiso Home Water Co., gave a short paper on "The Management of Water Plants in Small Cities." He said no place is so poor but that it can well afford to dispense at least a good safe water.

T. C. Phillips, Chief of the Chicago Water Survey, told the convention that in 1911 there was a waste of 19,000,000

gal. of water daily in the City of Chicago, at a cost of about $208,000 per year.

Dow R. Gwinn, of Terre Haute, read a paper entitled "The Chloride Process of Water Purification," prepared by W. B. Bull, of Chicago. This process has been introduced by Mr. Bull after a number of years experimenting along this line.

F. C. Jordan, of the Indianapolis Water Co., was reëlected as president and Dr. W. F. King, of the Indiana State Board of Health, was elected as secretary and treasurer.

Annual Meeting of the Connecticut Society of Civil Engineers

The 28th annual meeting of the Connecticut Society of Civil Engineers was held in New Haven, Conn., on Feb. 13 and 14. As usual, the meeting consisted of a business session in the morning of the first day, a lecture on that afternoon and a banquet that night, followed on the second morning with a series of technical papers. The technical sessions were held in the new Mason Laboratory of the Mechanical Engineering Department of the Sheffield Scientific School of Yale University. This building, recently completed, is a donation from two graduates of the Sheffield Scientific School. It is one of the most complete mechanical engineering laboratories in any engineering school in this country. The original donation comprised $250,000, $175,000 of which has been spent on the building; $55,000 is to be put in a fund for the maintenance of the building and the remainder is, or is to be, expended in various testing equipment. The features of the building are a large testing floor equipped with a 10-ton traveling crane and with a floor having parallel slots through which any machine under test may be bolted; a testing machine floor; a lecture room; a computing room and several offices for the faculty. No recitation halls are in the building, which is to be used entirely for laboratory purposes. It is hoped that when equipment is complete the laboratory will be in a position to conduct outside testing of value to the profession. Toward that end a resolution was introduced before the meeting, authorizing the president to appoint a committee to collaborate with the faculty of the school in arranging the details of such service of the laboratory to the engineering profession of Connecticut.

Two other resolutions of interest to the profession at large were introduced and adopted at the convention. One of them read as follows:

> Whereas, there is a great difference in the building ordinances and regulations throughout the state, and whereas there is an effort on the part of the different cities to improve their building laws, be it resolved, that this society raise a committee consisting of one member from each of the cities to keep in touch with this movement and work toward establishing a uniform building code in the state.

The second resolution was directed toward the conservation of the natural resources of the State of Connecticut and provided that a committee of the society be appointed to consider the development of the natural resources of the state and the sanitary regulations of the water courses of the state and to keep in touch with the laws upon the subject, so that the legislature may be informed by experts as to the necessities in this line of work.

Papers

The main lecture of the meeting was one by George W. Fuller, consulting engineer, New York, entitled "Recent Developments in the Art of Sewage Disposal." Mr. Fuller referred to the growing knowledge of the methods of sewage purification as exemplified by the great number of experimental investigations which had been carried on in this country in the past ten years. He presented a table showing the names of the cities where such experiments had been made and the amount of money expended at each of the places. Using as illustrations the views of a number of recent sewage-disposal plants, the speaker then showed some of the latest developments in this line of work. The main novelty which he described was the Imhoff combination sedimentation and septic tank, which has been installed in some three or four plants in this country, but which has reached a much greater use in Germany, where it was invented. Finally, Mr. Fuller brought the attention of the society to the necessity for sufficient maintenance of sewage-purification plants. He said that one of the most important functions of this society was to persuade public officials of the uselessness of employing an engineer to design a complicated sewage plant and then putting such a plant in the hands of entirely inexperienced men. Many failures of plants could be attributed to this cause.

Laying Submerged Pipe—Two papers were read which described work in Connecticut in laying large sized mains under rivers. These two were entitled "Submerged Water Pipe at Bridgeport," by F. S. Wardell, and "Submerged Gas Mains at New Haven," by H. G. White. The pipe at Bridgeport was a 30-in. line, for which flanged pipe was designed. It was found, however, in the laying of the pipe that a flanged pipe is exceedingly hard to make tight under water. The divers have great difficulty in screwing up all of the bolts to a tight joint. The gas mains at New Haven, on the other hand, were made with bell and spigot joints, calked, in the first pipes with lead pipe gasket and, when this proved ineffective, with small square sections of lead, by divers working with pneumatic tools. The pipes, which were two of 16-in. diameter each, were placed in six lengths of 12 ft., which were calked and joined together on a floating barge in a 72-ft. length, and were then dropped into place from a derrick carrying a light steel truss, to which the pipe was hung. Two of these mains were placed, one 300 ft. long across one river, and the other 200 ft. long across another river, both at New Haven. The pipes in the first river were placed on pile and timber-beam foundation, and in the second river, directly on rock.

Raising an Earth Dam—S. E. Minor, in a paper entitled "Raising Putnam Dam at Greenwich, Conn," described the work connected with raising an earth dam with concrete core wall, some 10 ft. in order to increase the area of one of the ponds which supplies the water for the city of Greenwich, Conn. The main interest in the description was in the fact that the core wall of the raised portion was made to fit over the old core wall, a narrow wall of concrete, in a U-shaped section which fitted closely to the old structure. The new dam section was made by filling entirely on one side of this core wall to increase the section to the proper size. Fill could not be made on the inside of the wall because the pond could not be emptied during the period which would have been necessary to have placed this earth.

The Saybrook Bridge—E. W. Bush read a paper entitled "The Saybrook Bridge over the Connecticut River." Mr. Bush was chief engineer of this structure, which was completed a short time ago. It is a highway bridge over the Connecticut River about three miles from its mouth, and connects the towns of Saybrook and Lyme. It is remarkable, not so much for its design as for the fact that it is the first bridge to have been built by and for the State of Connecticut. The state appropriated $500,000 for the construction of the bridge, and by the same act specified that a toll should be charged on it for 20 years. A bridge commission, serving without salary, was appointed to superintend the work, and this commission appointed the engineering force. This force retired at the end of the construction and it appears that the maintenance of the bridge will have to be under the charge of this non-technical commission which automatically expires in a few years. It is not known what steps will be taken by the state Legislature to provide for the proper maintenance and supervision of the bridge after that time.

The bridge consists of eight 159-ft. Warren trusses, a two-arm Scherzer rolling lift bridge of 200 ft. span and two 122½-ft. Warren truss approach spans. It is designed to carry ordinary highway traffic and a 60-ton trolley car.

The Shore Line Electric Railway—A. W. Sperry, the chief engineer of the Shore Line Electric Railway, read a paper

under the above title, describing the construction of this longest trolley which has been undertaken in Connecticut as a single project. The road runs from New Haven to Guilford, Conn., with some few outlying tracks and comprises 52 miles of total single track, of which 36 miles is on private way and 16 miles in highways in towns. It operates under 1200-volt direct current, which is generated in the company's own power house at 11,000 volts alternating current. In the cities, the cars are run on 600 volts direct current, the motors being geared in series so that they can so operate.

ENGINE-HOUSE FACILITIES — John M. Sullivan read a paper entitled "Cedar Hill Engine House Facilities," which described the design and construction of the recently completed engine-house yard and appurtenances built for the New York, New Haven & Hartford Ry. just outside of New Haven, Conn. This plant consists of a reinforced-concrete roundhouse, 1500-ton coaling station, engine water supply with a 55,400-gal. water tank, two cinder pits, an office, store and oil room and an extra turntable with track upon which another roundhouse may be some time built.

The roundhouse itself is of considerable interest. It is 360 ft. outside diameter and comprises 44 radial stalls, one of which is used for the entrance. The ground on which it is built is extremely marshy, being only some few feet above the adjoining river, so that it was necessary to found the entire structure on timber piles. These piles, 4400 of which were driven, were placed 2 ft. c. to c. and so driven as to carry from 7 to 8 tons per pile. Upon them a concrete cap 12 in. thick was placed with the piles reaching 6 in. into the concrete, and on this cap the concrete column was placed in radial lines marking the division of the stalls. The superstructure was of concrete with brick and glass outside walls. A drop pit, provided with hydraulic jacks, connects with the adjacent machine shop so that locomotives run in over the pit can be dismantled and their parts taken to the machine shop for repair.

OTHER PAPERS — Two other papers were read, namely, "New Haven Pavements," by Cassius W. Kelly, city engineer, New Haven, describing the various pavements which have been put down in that city in the past five years and giving some valuable cost data, and "The Wepawaug River Diversion Works," by Clarence M. Blair, describing the construction of a 6-ft. tunnel through solid rock which has recently been completed as a part of an additional water supply for the New Haven Water Co.

OFFICERS

For the ensuing year the following officers were elected: President, A. William Sperry; first vice-president, Sheldon E. Minor; second vice-president, George K. Crandall. The secretary and treasurer of the Connecticut Society of Civil Engineers is J. Frederick Jackson, of New Haven, Conn.

Annual Convention of the Engineering Society of Wisconsin

The fourth annual meeting was held Feb. 14 to 16, at Madison, the sessions being held in the Engineering Building of the University of Wisconsin. The attendance was small, and the Secretary's report showed a rather unfavorable financial condition. A proposition was made to increase the revenues by raising the dues, but no action was taken. Two sessions were held in conjunction with the County Highway Commissioners Association, and a joint subscription dinner was given by the Society and this Association.

Roads and Pavements—A large proportion of the papers related to streets and roads, as in the case of the meetings of other similar societies. In connection with this meeting of the highway commissioners there was a large outdoor display of road-making machinery.

In a paper on "The Work of the Wisconsin Highway Commission," H. R. Hirst (State Highway Commissioner) outlined the general plan of procedure, pointing out that the problem is how to do good work with the funds and materials available, and not merely to do such work as the Commission would like to do. The cost is divided equally between the State, the county and the township. For all bridges built under the State Aid System, complete plans must be submitted to the Commission. Of 1200 towns in the state, 508 have voted money for either roads or bridges; 479 voted $400,000 for roads and 123 voted $52,000 for bridges. About 386 miles of stone and gravel roads are to be built, and 246 miles of earth roads. About 150 bridges will be built, at a cost aggregating $1,250,000. The cost of road work done in 1910 and 1911 averaged $3000 per mile, including the grading. He thought the work could be done cheaper and better by day labor under the Commission than by contract, as the jobs are small, the foremen are likely to be inefficient, and an inspector from the Commission must be on the work all the time. With the day-labor system the men and foremen become skilled and constant inspection is not necesary. At present the difficulty is to get skilled road builders for all the work planned.

"Illinois Highway Work" was described by A. N. Johnson (State Highway Engineer); he also spoke on "Experiments with Earth Roads," the experiments being in the treatment of such roads with oil. "Road Improvement in Iowa" was the subject of a talk by Frank A. Nimocks. A paper on "Considerations in the Selection of a Street Pavement," by L. S. Smith (University of Wisconsin), dealt with various phases of both road and street work. He laid stress upon the fact that the question so often asked, "What is the Best Paving," cannot be answered without consideration of questions of traffic, topography, materials, etc. The "best" is that which gives the most needed service, a principle which is not generally followed. The paving of disconnected blocks in a line of street, or the use of different materials for adjacent blocks in one street (to suit the desires of property owners or others) are examples of bad and uneconomical practice. Cities usually plan their street work for each successive year, although some have adopted the wiser plan of preparing a general scheme for a term of years. Such a plan should be adopted also for country road work. Property owners in many cases demand a cheap pavement, because they have to pay the first cost, while the city pays for repairs and maintenance. The comparison should be based not on first cost alone, but on the annual cost of the street or road, as determined by the formula given below. In this, A = annual cost of road; S = annual cost on bonds for a sinking fund; C = first cost; I = rate of interest on bonds; L = life of pavement in years; R = total cost of repairs:

$$A = S + CI + \frac{R}{L}$$

He thought too much energy is being devoted to attempts to make paving stand up under conditions of trafic which it is not adapted to endure, this being especially the case with macadam. He spoke of the use of brick and concrete for country roads, and of the advantages of bituminous-macadam or bituminous-concrete pavements.

In the discussion it was suggested that such paving may be made with either stone or gravel, and if the latter is used, without infringing patents. It was pointed out also that the selection of paving material for streets is rarely left to the engineer, but is left largely to the property owners, who want a pavement of low first cost and are likely to be influenced by the promoters of special paving materials. What the property owners petition for the city council usually grants, regardless of the cost of maintenance.

A paper on "Wood Preservation," by F. N. Bond (Forest Products Laboratory, Univ. of Wis.) dealt mainly with the question of wood blocks for paving. A paper on "Methods of Preventing Dust on Macadam Streets," by John F. Icke (City Engineer, Madison) dealt with treatment by oil and tar compositions. It may be said here that the annual meet-

ings of engineering societies indicate the widening interest in the road-improvement question, and the joint meeting of engineers and highway commissioners at Madison suggests one way in which these societies can help very directly in the work of road improvement.

Sewage Pumping Plants—The report of the Committee on Sewerage and Drainage related particularly to the subject of sewage pumping plants, and instanced some examples. At Plymouth, Wis., there is a plant for forcing the sewage of a small territory over a dividing ridge, this being cheaper than a 30-ft. cut through the ridge. The force main consists of 460 ft. of 4-in. pipe, and the head is 30½ ft. The centrifugal pump is of the vertical type and has a capacity of 100 gal. per min. at 1200 r.p.m.; it is operated by a 5-hp. motor, and is started and stopped automatically by a float operating a switch. The station is an underground chamber 10x12 ft., 16½ ft. deep, entered by an ordinary manhole. In Madison, Wis., there are two sewage pumping stations, whose operations are controlled automatically. One of these (built 8 years ago) takes care of an area of 500 acres, and a 5-in. centrifugal pump delivers the sewage through 1800 ft. of force main to an intercepting sewer. The pump is operated by a 15-hp. motor, and the head varies from 6 to 14 ft. The other plant was installed in 1911 to take the place of a siphon or ejector, operated by water pressure; as no satisfactory starting device was available the siphon was running continuously, causing a heavy draft on the water works, besides overcharging the sewers. The pump chamber is under the street, and is 6x11 ft. A centrifugal pump with 6-in. suction and 4-in. discharge is operated by a 6-hp. motor.

At North Milwaukee, Wis., a similar pumping plant raises all the sewage to the filter beds. The sewage is collected in a settling tank and flows to the pump well; the pump has a capacity of 500 gal. per min. at 750 r.p.m., and is operated by a 10-hp. motor. A vertical device similar to a Venturi tube is used to aërate the sewage, air being drawn in at the contracted section of the pipe by means of a number of small tubes. This causes the sewage to be discharged in a foaming condition into the channel leading to the filter beds.

Four papers related to hydraulic subjects: one by F. M. Greve, Jr., discussed "Characteristic Curves for Centrifugal pumps"; Prof. Geo. J. Davis, Jr., presented "Notes on the Design of the Air-Lift Pump," being an abstract of a lengthy paper prepared by him and Carl R. Weidner, and published in the Bulletin of the University of Wisconsin. A paper by W. E. Miller dealt with "The Standpipe Failure at Sheborgan, Wis.," which accident was described very fully in ENGINEERING NEWS of Feb. 1. Prof. D. W. Mead gave an interesting illustrated lecture on "Flood Flows on Wisconsin Rivers"; this related especially to the great floods of the Autumn of 1911 (Which were described in ENGINEERING NEWS at the time) and to the serious results of the flood at the town of Black River Falls, Wis., where the obstruction of the flow by a dam caused the river to cut a new channel sweeping away a part of the town.

A paper on "Esthetic Values in Engineering Design," by Arthur Peabody, aimed to show that such values could be embodied not only in bridges and important works but in such a strictly utilitarian structure as a boiler house. Illustrations showed how a very simple and inexpensive architectural treatment resulted in a structure of pleasing appearance. Other papers were "Central Station Heating," by T. D. Crocket; "Mining Methods and Costs in Southwest Wisconsin," by Ralph E. Davis; "The Mineral Industries of Wisconsin," by Prof. Holden, and a somewhat lengthy and elaborate paper by F. A. Vaughan on "Relations of Modern Electric Meter Practice to Consumer, State Commissions and Central Stations."

The engineering faculty of the University did much to help the proceedings, and the opening address of welcome was made by F. E. Turneaure, Dean of the College of Engineering, who also gave an illustrated talk on "The Panama Canal." In his presidential address, the retiring president, Fred G. Simmons (Milwaukee) referred to the necessity of engineers keeping in touch with the developments in new methods and new branches of engineering work. The election of officers resulted as follows: President, P. H. Connolly, Racine, Wis.; Secretary, John C. White, Madison, Wisconsin.

An Architectural and Engineering Exhibition will be held in New York City at the 71st Regiment Armory, Park Ave. and 34th St., from Mar. 25 to 30. Models will be exhibited of buildings in Japan, China, Africa and India, as well as drawings and models of prominent buildings contemplated, or in course of construction, in this country. There will be also exhibits of building supplies, materials and accessories. In connection with the exhibition a conference of architectural, building, contracting and engineering interests will be held. Mr. A. D. V. Storey, 1269 Broadway, New York, is in charge of the exhibition.

The New Line of the Panama R.R. around Gatun Lake was to be put in operation on Feb. 15, according to the "Canal Record" of Jan. 31. Work on the taking up of the track of the old line from Gatun southward through the bed of the lake is to be pushed at once, as the level of Lake Gatun will begin to rise to the 50-ft. mark by April. The present line of the road from Gorgona to Panama will continue in use until the canal work is near completion. Trains will cross from the new line to the old line by means of tracks on top of the dike at Gamboa, which separates the waters of the Charges from Culebra cut.

Professor J. Burkitt Webb.

John Burkitt Webb, Professor of Mathematics and Mechanics at Stevens Institute of Technology from 1886 to 1907, died of pneumonia in New York City, Feb. 17. He was buried in Philadelphia, Penn., on Feb. 20.

Prof. Webb was a mathematician of rare ability. He was born in Philadelphia, Nov. 22, 1841. As a youth he exhibited deep interest in the work of his father, who was an amateur machinist and inventor, one of his early problems being the determination of the speed and angle of sails giving the maximum efficiency for a windmill which his father had invented. This early problem was typical of his entire life work.

At an early age he entered into partnership with Oberlin Smith at Bridgeton, N. J., establishing the business which has since grown to be the Ferracute Machine Co. He entered the University of Michigan in 1869 and upon graduation became Assistant in Civil Engineering, later taking charge of the Civil Engineering School at Illinois State University, where he remained eight years. He then spent two years in Europe attending lectures on pure mathematics, physics, etc., in the notable universities, including a year in Helmholtz's laboratory.

Through the acquaintance of Hon. Andrew D. White, President of Cornell University and United States Minister to Germany, Prof. Webb was appointed to the new chair of applied mathematics at Cornell in 1881, and five years later was called to Stevens Institute. In 1907 he retired under the Carnegie Foundation Pension Fund, and has since been engaged in consulting and private engineering work.

Prof. Webb was a member of the American Association for the Advancement of Science, the American Society of Mechanical Engineers, the American Mathematical Society, the Congregational Club of New York, the University of Michigan Round Table, and the Point O' Woods Yacht Club.

He invented his well known dynamometer in 1888, the viscous dynamometer in 1892, and the dynamophone in 1900. He was author of over seventy technical papers or lectures prepared for various societies. He brought forth a new method of determining bridge stresses and strains which has been largely used. His paper on "Overhauling of a Mechanical Power" exposed the fallacy of a law regarding hoisting tackle that had been announced by a high British authority and had been generally accepted.

Prof. Webb was devoted to the science of mechanics, giving his few spare hours largely to music, in which he was in-

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*Prepared by request by Prof. F. DeR. Furman, Stevens Institute of Technology, Hoboken, N. J.

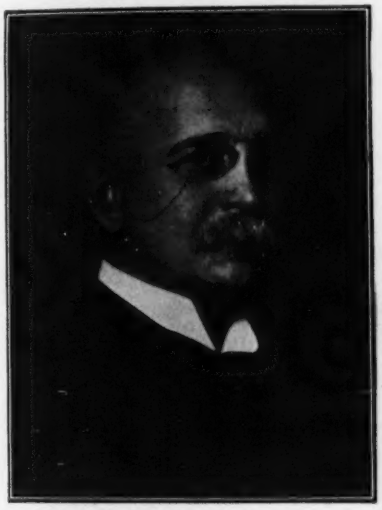
terested, being an organist in his early days at Bridgeton and Vineland.

He married Mary E. Gregory, daughter of the President of the Illinois State University, in 1876, who, with six children, survives him.

Francis H. Stillman

Francis H. Stillman, M. Am. Soc. M. E., President of the Watson-Stillman Co., died Feb. 18, at his home in Brooklyn, N. Y., from intestinal hemorrhage. His death came with little warning. The day previous he had spent at his office, apparently in the best of health.

Mr. Stillman was born in New York City, Feb. 20, 1850. At the age of 24 years he graduated from Sheffield Scientific School, Yale University, with the degree of B. S. Leaving college he was first associated with the Cottrell Printing Press Co., of New York City. Later he was associated with his stepfather, Mr.



FRANCIS H. STILLMAN

Lyons, in the firm of Lyons & Co., of New York, builders of hydraulic machinery. In 1883 he organized the firm of Watson & Stillman, which succeeded Lyons & Co. His partner, Mr. Watson, died nearly a score of years ago and Mr. Stillman continued the business, which was incorporated in 1904, becoming the Watson-Stillman Co., of which Mr. Stillman was President to the time of his death. Under his direction the firm has become widely known as manufacturers of hydraulic machines and appliances. The plant is located in Aldene, N. J.

Mr. Stillman was a member of many social and professional clubs and associations. He was one of the principal organizers of the Machinery Club, of New York City, and was its first President. He was a director of the National Association of Manufacturers, and was the first President of the National Metal Trades Association. Besides his interests in the Watson-Stillman Co., he was President of the Bridgeport Motor Co., of Bridgeport, Conn., and a director of other manufacturing concerns.

He was a man of affable disposition and of high business integrity, and his circle of warm personal friends was very wide.

Mr. Stillman was married to Miss Irene Bancroft, of Boston, Mass., who, with two sons, survives him. The sons, Austin F. and Edwin A., are both mechanical engineers and have been associated with their father in the Watson-Stillman Co.

A Derailment at Warrior's Ridge, Penn., Feb. 15, on the Pennsylvania R.R. caused the death of four persons and the injury of 51 others of the 103 passengers. Nine of the 11 cars of eastbound limited express train No. 2 left the track and rolled down the embankment to the edge of the Juniata River. The two locomotives and the car immediately behind them remained on the rails, as did also the observation car. All the cars were of steel. The accident is ascribed by press reports to the drooping of some part of the running gear of one of the locomotives or of the first car.

The westbound counterpart of this same train, known as No. 5, was wrecked Feb. 17 in a rear collision with a work train at Larwill, Ind. The accident occurred at 5:40 a.m., and is ascribed to a fog. The work train, ahead of the limited, had been stopped by a trackman because of a broken rail. The limited, according to reports, ran past a block signal and a flagman sent back from the train ahead. Three cars of the work train were demolished and five men in the caboose were killed. The locomotive and first two cars of the limited were derailed. None of the passengers was hurt.

A Locomotive Fell Through the Roof of the Citizens' State Bank at Bingham, Utah, Feb. 15. According to press reports, the engine was derailed at a curve of the Copper Belt R.R. on the side of the hill some 75 ft. above the street. Besides the bank, three other buildings were partly wrecked. Two men on the locomotive and three sleeping in one of the buildings were killed.

Subterranean Sea Erosion is assigned in a press report as the cause of the collapse of the San Remo roadway on the Italian Riviera, Feb. 13, about 26 miles from Nice. Some 45 children, according to the report were carried down with the roadway into the underground waters and five were drowned.

A Tramway Cable Broke, Feb. 9, at the Pathfinder dam on the North Platte River, 50 miles southwest of Casper, Wyo., and caused the death of five workmen. A report in the Denver "Post" states that the accident occurred at a point 100 yd. below the dam where an aërial cableway spans the cañon. The south end of the cable, the report continues, broke from its anchorage and carried down with it a scaffold upon which the men killed were at work building a steel ladder up the south wall of the cañon.

At the Clay Products Exposition in Chicago, Mar. 7 to 12, one of the features will be a full-width street paved with vitrified brick. This will be exhibited in the Coliseum Annex, a room 70x170 ft. in size. During the exposition, expert workmen will be engaged on this model street in laying pavement of this sort to show the most approved method. A part of the street will be given up to a make-believe ditch with walls supported by steel sheet-piling. A gasoline-driven traction ditcher will be shown at work, and in the ditch will be workmen laying salt-glazed vitrified sewer pipe, showing four or five different types of water-tight joints. House connections will be shown together with catch basins, flush tanks, manholes and other equipment.

The Proposed Increase of Freight rates on empty cement sacks returned by cement users, noted in our issue of Jan. 18, p. 124, has been abandoned, through the efforts of the Association of American Portland Cement Manufacturers.

The Smoke Problem in Pittsburg is to receive a broad investigation by the Department of Industrial Research of the University of Pittsburg under the direction of Robert Kennedy Duncan, R. C. Benner and W. W. Strong. The main line of study will be into the effect of smoke on health, plant life and buildings. Various other questions involved will also be considered such as (1) the increased cost of living due to smoke and dirt damage, (2) legal aspects, and (3) engineering features. The investigators desire to get in touch with all persons interested in such work for suggestions, information and coöperation.

A 3½-Story Reinforced-Concrete Building, 150x800 ft. in plan, under construction for the Spang-Chalfant Co., at Etna, near Pittsburg, Penn., collapsed on Feb. 19, causing the death of one workman and the injury of several others. Details of the collapse were not available when this issue went to press.

Personals

Mr. Herman Eymer has been appointed City Engineer of Saginaw, Mich., succeeding Mr. R. W. Roberts.

Mr. O. E. Weller, of Baltimore, Md., has been appointed Chairman of the States Roads Commission of Maryland, at a salary of $2500 per annum.

Mr. H. G. Opdycke, formerly of the firm of Opdycke & Deutsch, 50 Church St., New York City, is continuing business individually at the same address.

Mr. Walter N. Frickstad, Assoc. M. Am. Soc. C. E., for a number of years employed in office of the City Engineer of Oakland, Calif., has been appointed Assistant City Engineer, as the result of a competitive civil service examination.

Mr. Ross Thompson, Assoc. M. Can. Soc. C. E., of Sydney, N. S., has been appointed Chief Engineer of the St. John & Quebec Ry. Mr. S. B. Wass, Assoc., M. Can. Soc. C. E., of Presque Isle, Me., has been appointed Assistant Chief Engineer.

Mr. William M. Brown, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Sewerage Works, of Boston, Mass., has been appointed Chief Engineer of the Passaic Valley Sewerage Commission, succeeding Mr. E. W. Harrison, M. Am. Soc. C. E., resigned.

Mr. George W. Brymer, formerly Chief Engineer of the northeastern division of the Pennsylvania Coal & Coke Co. at Cresson, Penn., and later Division Superintendent at Patton, Penn., has been ap-

pointed Superintendent of the Edgewater plant of the Tennessee Coal, Iron & R.R. Co., at Ensley, Ala.

Messrs. W. H. Cunningham and C. R. Conner, General Manager and Manager of Mines, respectively, of the West Kentucky Coal Co., Sturgis, Ky., have resigned and formed a partnership under the firm name of Cunningham & Conner, Consulting and Contracting Engineers, with offices in the Robeson-Prichard Bldg., Ashland, Ky.

Mr. Edlow W. Harrison, M. Am. Soc. C. E., Consulting Engineer and Chief Engineer of the Passaic Valley Sewerage Commission, has resigned because of ill health. In accepting his resignation the commission adopted resolutions setting forth its regret at the step Mr. Harrison felt compelled to take and expressing its appreciation of his services.

Obituary

William Wilkes Young, Purchasing Agent of the Union Switch & Signal Co., Swissvale, Penn., died on Jan. 25.

Atwell Thompson, City Engineer of Jackson, Tenn., and formerly in charge of construction at Chickamauga Park, Ga., and the Shiloh National Park, died recently at his home in Jackson.

Augustus Bouldin, City Surveyor of Baltimore, Md., from 1882 to 1896, and until a few years ago a member of the firm of Bouldin & Co., Consulting Engineers, of Baltimore, died in that city on Feb. 7.

Henry Mason, formerly Superintendent of the Wabash, Chester & Western R.R., died on Feb. 10, at his home in Pinckneyville, Ill. He was born in Ireland, Oct. 18, 1844. He came to this country and began railway work in 1862 as a section hand on the Illinois Central R.R.

Daniel L. Harding, formerly a civil engineer with the Ft. Wayne, Cincinnati & Louisville R.R., and at one period Mayor of Fort Wayne, Ind., died on Feb. 11. He was born in Ireland 69 years ago. He came to this country in 1866, and was engaged in railway construction work for a number of years.

Lorenzo Hobbs, a pioneer building contractor of Omaha, Neb., died in Norfolk, Neb., on Feb. 5, aged 86 years. He was a contractor for most of the stations and section houses on the Union Pacific Ry. through Nebraska and Wyoming. He was a native of Boston, Mass., and emigrated to Omaha in 1856.

William Chattin Wetherill, M. Am. Soc. C. E., Consulting Engineer of the Empire Zinc Co., Denver, Colo., died on Feb. 10. He had lived in Denver for the last 20 years, going there from Baltimore, Md. He was 65 years old. Mr. Wetherill was elected a member of the American Society of Civil Engineers in 1886, and therefore ranked among the society's older members. He is survived by a widow and two daughters.

Dr. H. T. Bovey, Past President, Can. Soc. C. E., for many years Professor of Civil Engineering and Applied Mechanics at McGill University, Montreal, Que., died at Eastbourne, England, on Feb. 2. Dr. Bovey was born in Devonshire, England, in 1852. He was educated at Queen's College, Cambridge, and received his first engineering experience with the Mersey Docks and Harbor Board of Liverpool.

After some years' service here, he was called to Canada to become a member of the faculty of McGill University. To him much credit is due for the development and high standing which the University subsequently attained as an engineering school. He was the first dean of the Faculty of Applied Science.

He was one of the founders of the Canadian Society of Civil Engineers and served both as Vice-President and President. He was a member of the Institution of Civil Engineers, of Great Britain, and a founder of the Liverpool Society of Civil Engineers.

In 1908 he resigned his professorship at McGill University, after 29 years of continuous service, and returned to England as Rector of the Imperial College of Science and Technology in London. He was soon obliged to resign this office, on account of failing health, and since then had lived in London, spending long vacations in Italy and France.

He was a frequent contributor to the proceedings of the various societies of which he was a member, and was the author of well known textbooks on hydraulics and strength of materials.

He is survived by a widow, who was Miss Redpath, of Montreal, and five children.

Clinton B. Sears, Brigadier-General, Corps of Engineers, U. S. A., retired, died at his home in Newton Center, Mass., on Feb. 17. He was stricken with apoplexy on a Boston subway train. Gen. Sears was born at Penn Yan, N. Y., June 2, 1844. He was educated in the public schools, Ohio Wesleyan University and the United States Military Academy, at West Point, where he graduated third in his class in 1867. He had been a soldier, however, before he entered West Point Academy, for in 1862, immediately following his graduation from Ohio Wesleyan University, he entered the service as a private in the 95th Ohio Infantry. He was promoted to corporal, acting color sergeant, and the following year was appointed a cadet at West Point Academy, where he distinguished himself as a student as well as a soldier. His appointment to a cadetship was recommended, after a competitive examination held in the army at the front, by both Generals Grant and Sherman.

He was commissioned Second Lieutenant of the Corps of Enginers in 1867, and detailed as Assistant Professor at the Military Academy in civil engineering; later he was made Professor of geography, history and ethics, and from 1878 to 1882, Professor of mechanics, acoustics, optics and astronomy. For a year following he served as Instructor in submarine mining at the U. S. Engineer School.

One of his most important assignments later in life was that of Chief Engineer of the Division of the Philippine Islands, 1901-1903. While at this post he had charge of the construction of military roads and bridges and the improvement of Manila Harbor and the Pasig River. Returning to this country in 1903 he was placed in charge of the improvement of the Cumberland and other rivers in Tennessee, of jetty work at the mouth of the Mississippi River, and of the improvement of the river from St. Louis, Mo., to Cairo, Ill. Gen. Sears was a member of the Mississippi River Commission from 1906 to 1908, and a member of various other special boards and commissions. He was retired on June 2, 1908.

Engineering Societies

COMING MEETINGS

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Mar. 4-6. Annual meeting at Chicago, Ill. Secy., Will P. Blair, 824 Engineer's Bldg., Cleveland, Ohio.

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 5-6. Annual meeting at Urbana, Ill. Secy., E. Bartow, Urbana, Ill.

NATIONAL BRICK MANUFACTURERS ASSOCIATION.
Mar. 6-9. Annual convention at Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

CANADIAN MINING INSTITUTE.
Mar. 6-8. Annual meeting at Ottawa, Can. Secy., H. Mortimer Lamb, Room 3, Windsor Hotel, Montreal, Can.

NATIONAL ASSOCIATION OF CEMENT USERS.
Mar. 11-16. Annual convention at Kansas City, Mo. Secy., Edward E. Krauss, Harrison Bldg., Philadelphia, Penn.

AMERICAN BOILER MANUFACTURERS ASSOCIATION.
Mar. 12-15. Annual convention at New Orleans, La. Secy., J. D. Farasey, East 37th St. and Erie R.R., Cleveland, Ohio.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 19-21. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.
Mar. 28-29. Annual meeting at New York City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

Wood Preservers Association—This association has arranged to take a number of technical periodicals and to index all articles pertaining to timber preservation. A list of such articles is then sent to the members every month, giving for each subject a brief statement regarding it and the number of words contained, with the name and date of the periodical. F. J. Angier, B. & O. R.R., Baltimore, Md., is Secretary.
R. P.—SOC. PROC.

American Boiler Manufacturers Association—Among the papers to be presented at the 24th annual convention, Mar. 12-15, in New Orleans, La., are the following: "The Manufacture of Charcoal Iron Boiler Tubes," H. A. Beale, Jr., President, Parkersburg Iron Co., Parkersburg, Penn.; "Boiler Explosions, Their Causes and Prevention," F. B. Allen, Vice-President, Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.; "Modern Boiler Shops and Their Equipment," H. C. Meinholtz, Superintendent, Heine Safety Boiler Co., St. Louis, Mo. The formulation of a set of uniform boiler laws will be undertaken at this convention.

Engineers Club of Toronto—Officers for the coming year have been elected as follows: President, Willis Chipman; Vice-Presidents, T. S. Young, J. J. Ashworth and C. H. Heys; Secretary-Treasurer, R. B. Wolsey.

Associated Engineering Societies of St. Louis—At a special meeting held, Feb. 14, under the auspices of the St. Louis section of the American Institute of Electrical Engineers, Mr. F. M. Jewettt presented a paper on "Central Station Heating."